AD-A165 403 PROJECT EXECUTION PLAN FOR NORLANT REPAIRS(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE DIV 31 MAY 76 1/2

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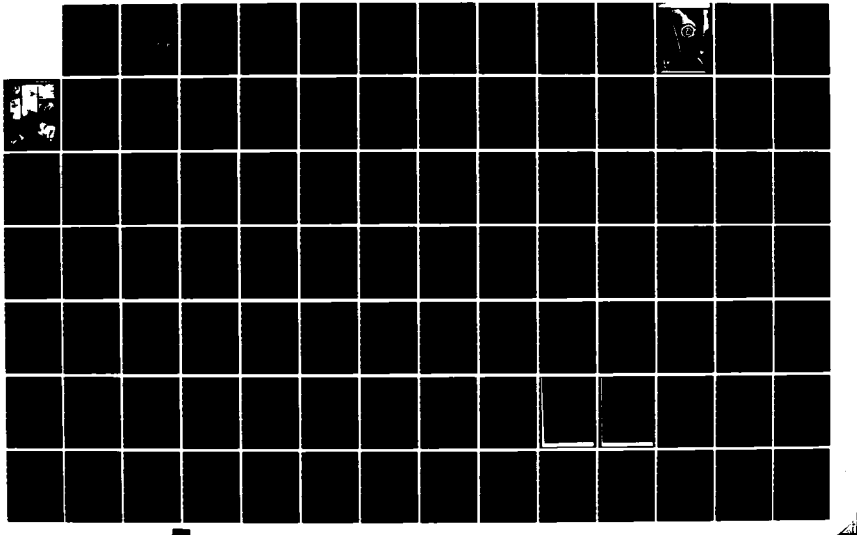

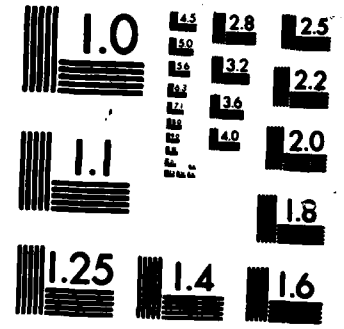

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PROJECT EXECUTION PLAN
FOR
NORLANT REPAIRS

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Ocean Engineering and Construction Project Office
Chesapeake Division, Naval Facilities Engineering Command
Washington, D. C. 20374

31 May 1976

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APPROVED
R. A. ERCHUL, CDR, CEC, USN
Head, Ocean Engineering and
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1.0 PROJECT DESCRIPTION

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1.1 SUMMARY OF PROBLEM

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1.2 SCHEDULE OF MAJOR EVENTS

	EVENT	DATE
1.	Tasking and funding of involved commands	1 April 1976
2.	Completion of project execution plan, specs for splicing operation and immobilization operations	31 May 1976
3.	Approve plans and specs	24 May-4 June 1976
4.	Procure, assemble, package and ship: team diving and construction equipment; splicing equipment; all non-organic construction materials	1-31 May 1976
5.	Personnel transit to operation area	1 June 1976
6.	Local on-site coordination	2-8 June 1976
7.	Cable Repair Operations	8 June - 15 July
8.	Cleanup Operations	16 July - 30 July
9.	Personnel transit to US	31 July 1976
10.	Completion Report	30 Sept 1976

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2.0 ORGANIZATION RESPONSIBILITIES

2.1 TASKING

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2.2 ORGANIZATION

The formal organizational interface between the various participants as it affects the prosecution of this project is indicated in figure 2.

The organizational responsibilities are outlined as follows:

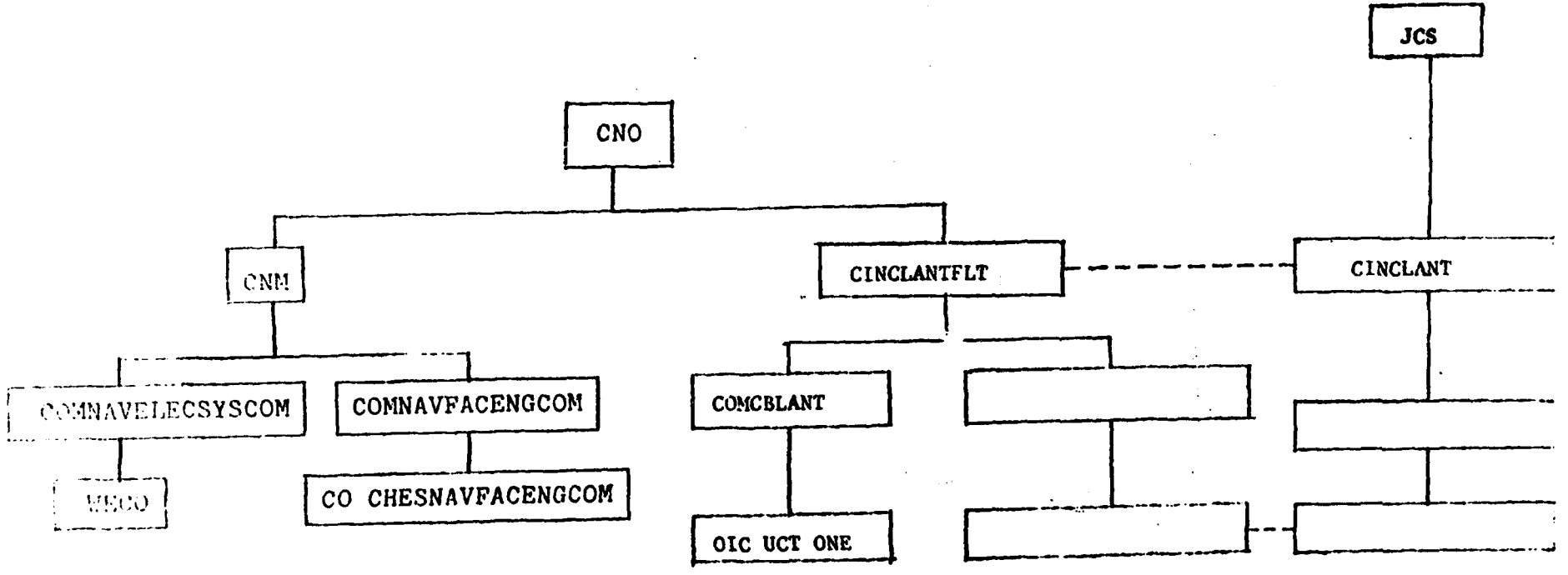
1. NAVELECSYSCOM: System customer; responsible for initiating tasking and project funding; overall technical responsibility including responsibility for approval of all project plans and specifications.

2. UCT-ONE: OIC of project; operational control of project; responsible for procurement of team construction and diving equipment.

3. WECO: Technical responsibility for splicing operations; responsible for procurement of splicing equipment, and cable continuity checkout.

4. CHESNAVFACENGCOM: Technical responsibility for immobilization operations; responsible for financial management and for procurement of materials and equipment non-organic to UCT-One or WECO; responsible for project planning.

5. NAVSTA: Provide on-site support in men and materials for beach station preparation and final cleanup; provide berthing and messing for detachment personnel; provide area coordination.



ORGANIZATIONAL CHART

FIGURE 2

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3.0 SYSTEMS AND COMPONENTS

3.1 CABLE SYSTEM

The underwater cable to be repaired is the loop cable system. The cable is Type coaxial cable with an outside diameter of approximately 3.3 inches and an air weight of 11 pounds per foot. The affected section of cable is double armored with neoprene jacketed armor wires. An 1/8" thick lead shielding is utilized in this section under the armor wires and around the cable conductor insulation. The added lead shielding changes the normal bend radius of the cable from 3 feet to 15 feet. Figure 3 is a photograph of a section of the loop cable.

3.2 STABILIZATION SYSTEM

Undersea cable is stabilized by first enclosing the cable in split pipe and then securing the split pipe to the sea floor using U-rods and rock bolts.

The split pipe is manufactured in approximately 3' sections of nodular cast iron pipe split longitudinally, each half section weighing 70 lbs in air. Inner diameter of the pipe is 3-1/2". The split pipe has an interlocking bell joint feature that develops the "continuous" flexible length of split pipe along the cable. Figure 4 depicts a typical installation of a split pipe around an undersea cable.

3.2.1 U-RODS

The split pipe is physically fastened to the sea floor using U-rods and rock bolts. Each U-rod consists of a 4 ft. length of 1 inch diameter CRES bar bent into a "U" configuration with an 8 inch clearance between the legs. The U-rods straddle the split pipe and for installation require drilling a 2-1/2 inch to 3 inch diameter hole 18 inches deep, on each side of the section of split pipe to be secured. A drilling jig is used to accurately position the holes. For this installation, the U-rod ends will be inserted in the holes. Waterproof grout will then be squeezed from plastic bags into the holes. When the grout sets, the U-rod is secured to the bottom. Installation time is approximately 45 minutes per U-rod. Figure 5 is a photograph of a 1 inch diameter type 316 stainless steel U-rod being inserted over a section of split pipe. This type of U-rod will be used to immobilize the cable. In previous U-rod installations, the

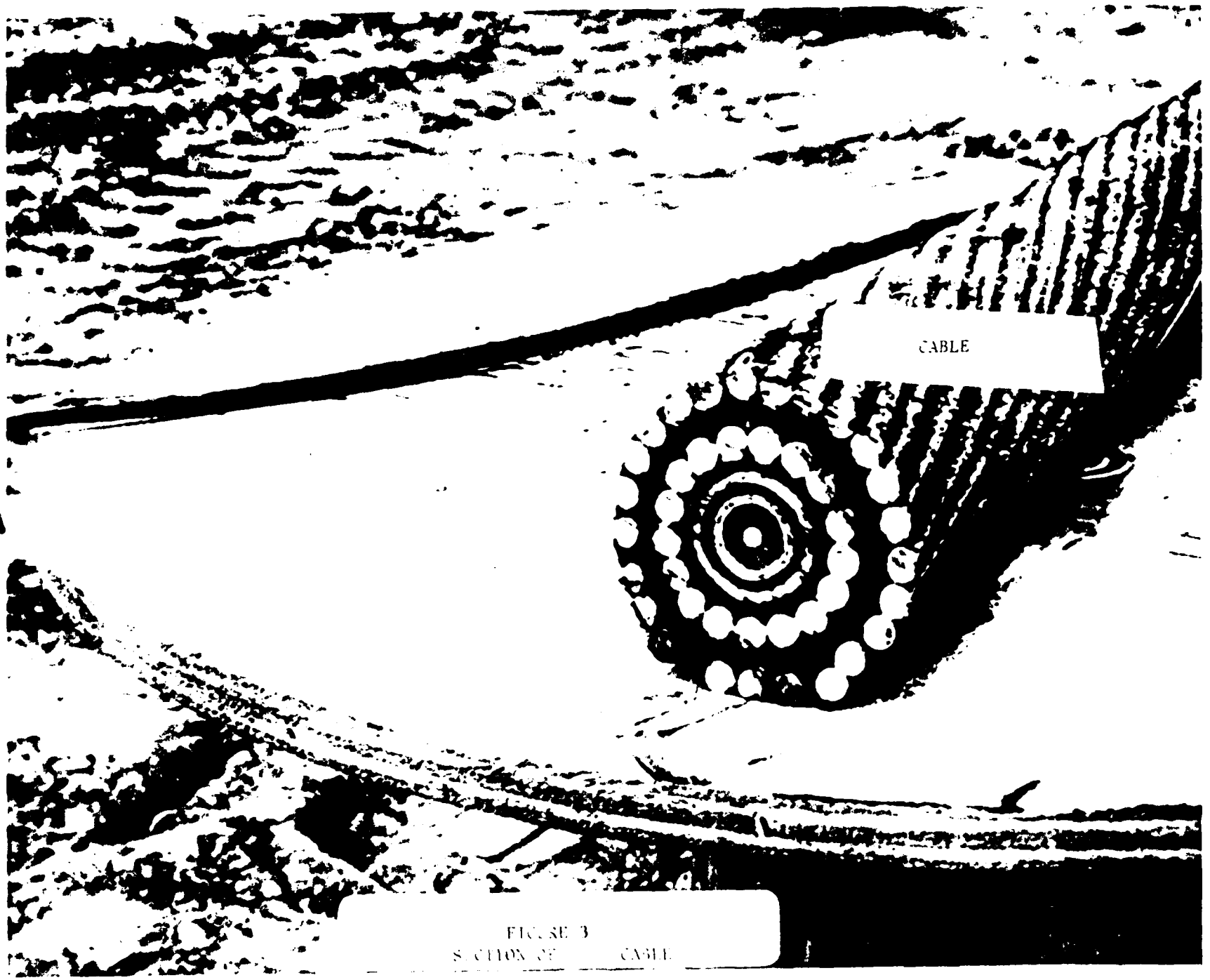
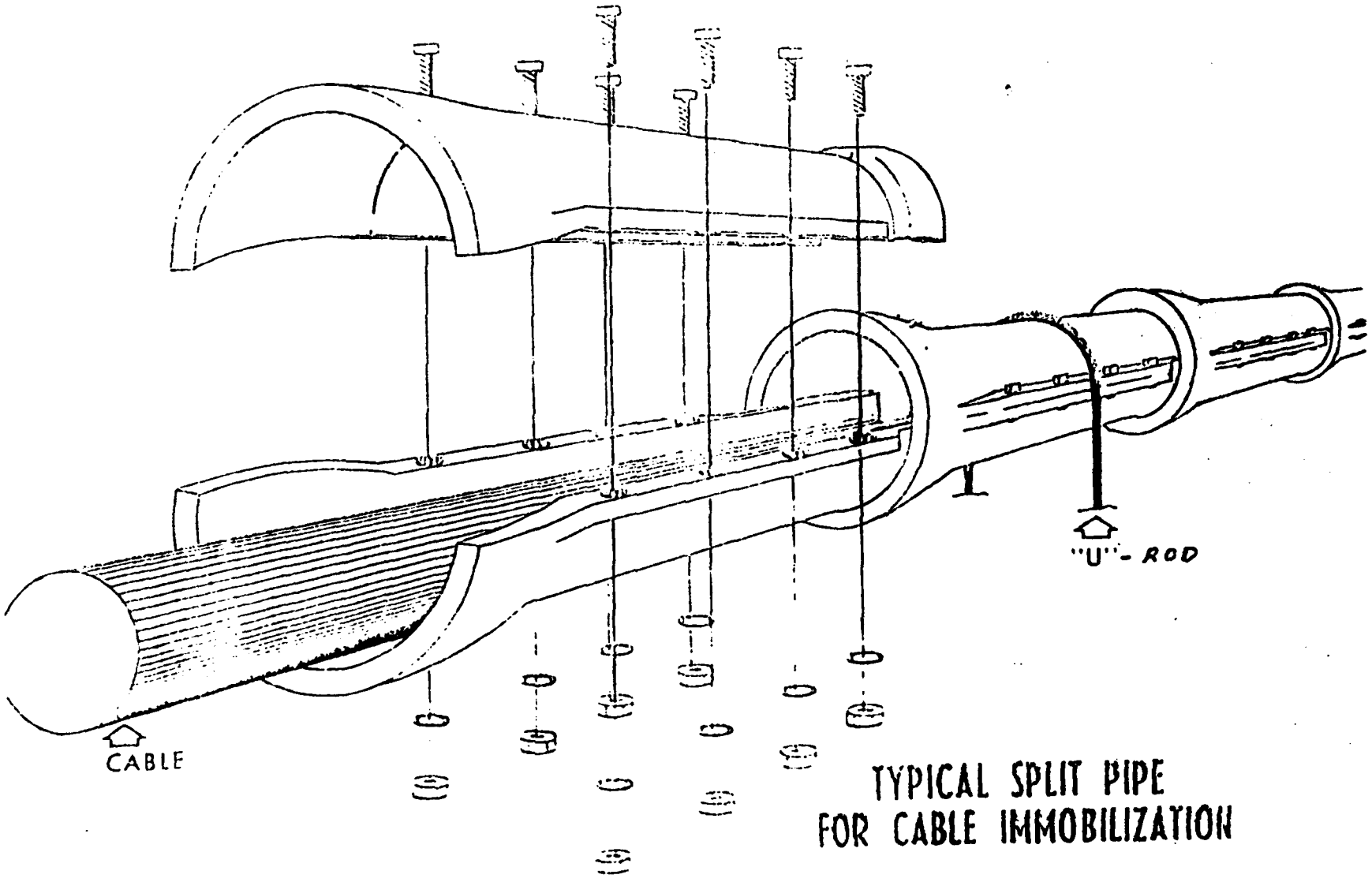


FIG SE 3
SECTION OF CABLE



TYPICAL SPLIT PIPE
FOR CABLE IMMOBILIZATION

FIGURE 4

U-rod has been notched (indicated in figure 5) to impart a good holding surface when grouted in the drilled hole. Notching the rods is an expensive approach, difficult to control and may reduce the strength of the rod. Therefore, this approach will not be used for this repair. Instead, each end of the U-rod will be threaded and a nut placed on each threaded end. It is anticipated that the threads and nut on each end of the U-rod will preserve the rod's strength and still impart a good holding mechanism with the grout.

3.2.2 ROCK BOLTS

Rock bolts are made of high-carbon zinc plated steel and are 5/8 inch diameter, 12 inches long with 4 inches of threads on the upper end. The upper end fits through the existing bolt holes in the spilt pipe. On the lower end of these bolts, there is a mansonry wedge anchor which develops the bolt's holding power in rock. To accommodate the wedge anchor, a 6 inch deep, 5/8 inch diameter hole is drilled in the rock. Figure 5 shows a rock bolt inserted in a section of split pipe. Installation time is approximately 10 minutes per rock bolt.

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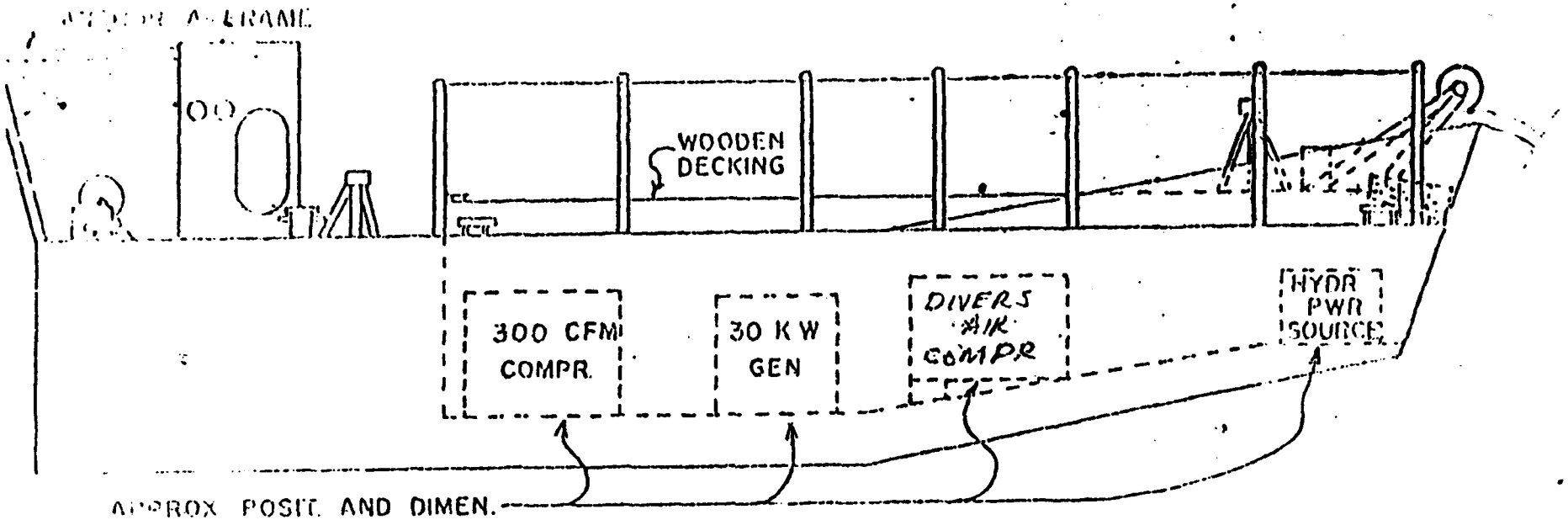
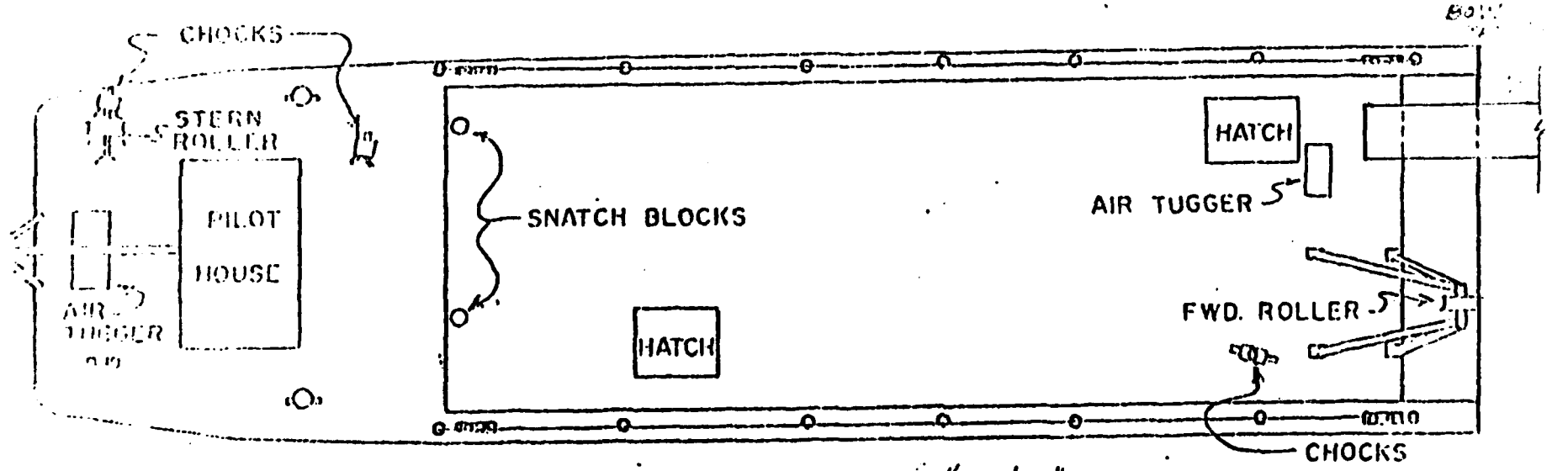
The general tendency is to utilize rock bolts exclusively for cable immobilization due to their reduced cost and ease of installation. However, sufficient data has not been obtained regarding actual rock bolt lifespan. Therefore, a combination of U-rods and rockbolts will be used for pinning the cable to the seafloor in this project.

3.3 CONSTRUCTION SYSTEM

3.3.1 PLATFORM

An LCM-6 will be the basic construction platform for executing this project. In order to facilitate lifting, splicing and overboarding cable for this project, a number of modifications will be made to a convential LCM-6. Figure 6 is a profile and plan view showing the intended modifications to the LCM-6. Certain details have been omitted in figure 6 for clarity. A detailed list of the material required to modify the LCM-6 is given in Appendix C. The following modifications will be made to the LCM-6:





APPROX. SCALE 1" = 6'-0"

LCM-6

- Install two (2) weatherproof metal cabinets (not shown in figure 6), 3 feet wide, 8 feet long, and 5 feet high, in the Well Deck area. These cabinets are to house the splicing and testing equipment during transit to and from the cable repair area.

- Install a 30KW diesel generator below the Well Deck to power cargo lights and splicing equipment.

- Install a wooden platform over the Well Deck, from the Engine Room Deck to the Bow Ramp, extending the width of the Well Deck. Support of the wooden platform will be accomplished by utilizing existing 4" x 4" x 1/2" angles welded to the gunwales of the LCM-6. Transverse 4" x 6" timbers placed on 43" center will be decked over longitudinally with 2" x 6" planking. The final deck covering will be made of 3/4" plywood.

- Install two gated chocks on the starboard side forward end on the open deck and two gated chocks on the port side, aft end, of the wooden platform deck. These chocks should be mounted on a three-foot high tripod welded to the metal deck aft and bolted to the wooden platform forward. All chocks must hold up to 10,000 pounds in the horizontal direction.

- Provide portable stanchions placed approximately every six feet along the gunnel on the open deck, the length of the wooden platform deck. These stanchions should be five feet in height since they are used as side supports for the portable splice tent in addition to being used as lifeline supports.

- Provide a portable splicing tent to shelter the splicing area from rain and salt spray.

  a. Provide tent framing, including the stanchions mentioned above, of light metal for easy assembly and disassembly, with the overhead of the tent along the center line allowing a seven-foot minimum headroom.

b. Provide a lightweight waterproof material to be placed over the metal tent frame for use as a splice tent. This material must be equipped with grommets or tie downs, easily accessible for expedient assembly and disassembly.

NOTE: It is important that the entire tent assembly be portable since part or all of it must be disassembled in order to overboard each splice.

- o Install four 1/2-inch steel padeyes (not shown in figure 6), two forward and two aft, on the LCM-6. These padeyes shall be installed as directed by the Western Electric Company representative on site.
- o Provide ten 8" long threaded eye bolts to be used as tie-down eyes for the splicing equipment on the platform deck.
- o Provide four cargo light clusters with proper wiring to the generator for use during splicing operations. Sea plugs should be used to preclude rain or salt water penetrating the electrical sockets.
- o Provide collapsible, two legged, wooden horses for supporting cable ends off the platform deck during splicing operations.
- o Install a low-pressure air tugger on the fowarded end of the Well Deck as directed by the Western Electric Company representative on site.
- o Install a low-pressure divers' air compressor.
- o Install a 300 CFM compressor for the air tugger
- o Install a hydraulic power source for powering diver tools.
- o Provide 4 spare sea plugs and one 50 ft extension cord to be used in wiring the splicing equipment to the 30 KW generator.
- o Install two hatches approximately 3 feet square in the above platform to facilitate free access to the Well Deck.
- o Install two wooden ladders (not shown in figure 6) for the above mentioned hatches.

Two LARC-5's outfitted with towing posts will be utilized to support cable splicing and scuba operations. A 16' Boston Whaler and three inflatable ZODIACS will be available for general purpose support.

3.3.2 TOOLS

A collection of newly developed diver tools will greatly assist project completion. Brief descriptions of several of these tools are included here for information.

o Mechanical Nut Splitters

Four sets of mechanical nut splitters will be available. These devices will serve to shatter the nuts holding the split pipe together if the nuts cannot be unbolted. An abrasive grinder is the other acceptable tool for nut removal.

o Hydraulic Band Saw

Two hydraulic band saws will be available for U-rod removal. The previously established method for U-rod removal involved slashing the rod completely through with an 1/8 inch abrasive cutter and then bending the U-rod out of the way with brute force.

o Hydraulic Rock Drills

Two small-hole (1-inch) and one large-hole (3-inch) hydraulic rock drills will be utilized for rockbolts, moorings and split pipe immobilization. The smaller rock drills have proved most beneficial in drilling the smaller holes required for rockbolt installation. These rockbolts will be utilized for small craft moorings and to pin the split pipe to the seafloor.

The large-hole hydraulic rock drill will be used for the installation of U-rods. It drills the 3-inch holes in the rock into which the U-rod fits. A pneumatic rock drill is the only other method available to drill such holes.

Back-up systems to the aforementioned tools will be available if required. These include a wide variety of pneumatic equipment.

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4.0 OPERATIONAL PROCEDURE

4.0.1 General Repair Procedure

The basic single point splicing operation of near-shore undersea cables is accomplished in five phases. The first phase is removal of the old stabilization system. This entails cutting rock bolts and U-rods away from the split pipe/cable and then removing the split pipe from the cable by cutting the bolts holding the pipe half sections together. Sufficient split pipe must be removed to allow for the pulling of one end of the cable on the deck of the construction platform, in this case an LCM-6, without violating the minimum bend radius requirements for the cable. A continuity check is made when the cable end is brought on-board.

The second phase encompasses mooring preparation. A six point moor must be placed over the faulted area. The moor must be capable of holding an LCM-6 in up to sea state 3. Also, the moor must allow the LCM-6 to warp from point to point within the area for later underrunning of the cable. The installation of the moor may take place any time prior to the splicing operation. It is preferable that the moor be placed as soon as the exact location of the fault is known. This will allow for the mooring to be used in support of the removal of the stabilization system.

The next phase of the operation requires flotation of the cable ends to which splices will be made and placing of these ends -one at a time- on the deck of the LCM-6. This may require cutting the cable at the fault area should a clean break not have occurred. Each end of the cable is raised separately and a repair link of cable is spliced between the two bitter ends of the raised cable.

The fourth phase of the repair operation calls for reapplication of split pipe to the now repaired cable. Most of this operation can be accomplished on the deck of the LCM-6. Final mating of the split pipe on the repair link with the split pipe on the original cable has to be effected by divers. The cable with split pipe attached is overboarded during this phase of the operation and lowered in a controlled mode to the bottom by selective removal of buoyancy.

The last phase of the repair operation is the placement of the final sections of split pipe underwater and pinning of the protected cable system to the bottom. This phase is of the longest duration (aside from the initial CA mobilization).

4.0.2 Present Repair Operations

The following sections will detail specifically for the present operati predeployment and on site preparation, the cable testing and the cable repair which involves three alternative and contingency procedures.

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4.1 PRE-DEPLOYMENT PREPARATION

Before the construction team deploys the following tasks will be accomplished.

1. Identify skills, number of personnel, equipment, and materials required to effect the cable repair.

2. Order materials.

3. Determine the weight and cubic feet of equipment and material that must be air transported with the construction team.

4. Surface ship all equipment and material that cannot be air transported with construction team.

5. For surface ship transported equipment and materials, arrange for ship offload, transportation to and storage at Naval Station.

6. Obtain necessary area clearances.

7. Secure billeting and messing at the Naval Station, for all military and civilian personnel.

8. All personnel obtain required immunization to enter foreign port.

9. Check or obtain official passports for all civilian personnel.

10. For air transported equipment and material, arrange for aircraft offload, transportation to, and storage at the Naval Station.

A complete list of equipment and material that will be transported to the Naval Station is contained in Appendix C.

4.2 ON-SITE PREPARATIONS

The following tasks will be accomplished after all personnel, equipment and material have reached the Naval Station. These tasks are common to Alternative A, Alternative B and the contingency plan.

1. Brief all participants on project plan.

2. Coordinate with officials of local government.

3. Establish point of contact for obtaining weather forecasts.

4. Excavate 2000' of repair cable from onshore assets. Cut repair cable into 2, 1000' sections.

5. Obtain splice materials.

6. Establish cove mooring. Figure 7 is a recommended mooring configuration.

7. Set range lights.

8. Complete LCM-6 modifications and checkout LCM-6.

9. Transit LCM-6 to cove area.

10. Transit construction team, and stage equipment and material at beach station.

11. Establish beach station as follows:

    - o set up diving locker
    - o level the beach
    - o ready the recompression chamber

12. Check LARC-5's out.

13. Swim and inspect

14. On the cable locate and mark the north sandbar and the known cable break with surface floats.

15. Attach surface floats every 100 ft along the cable.

16. Analyze the results of the cable inspection to determine whether rock bolts or concrete clumps will be used to moor LCM-6 during testing and splicing operation.

17. If necessary load concrete clumps at pier and transport to repair site.

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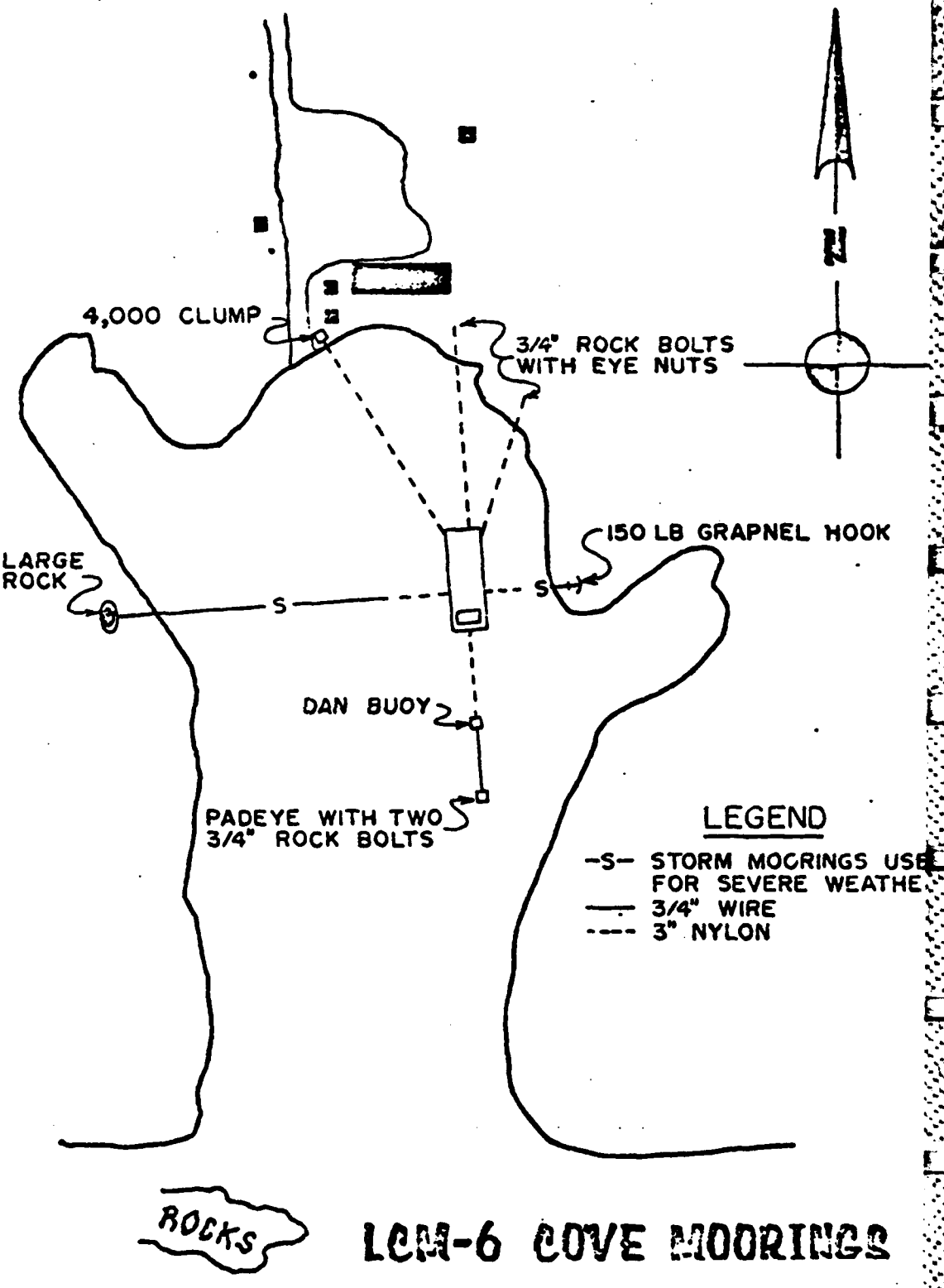

LCM-6 COVE MOORINGS

FIGURE 7
(NOT TO SCALE)

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Mooring configurations for the cable test, each alternative and the contingency plan are shown in section 4.3 Cable Repair.

The recommended mooring buoy configuration is shown in figure 8.

4.3 CABLE REPAIR

The repair of the cable will be effected by one of the two alternative approaches outlined in 1.1. Two factors are crucial in this particular cable repair:

- o results of the cable continuity test
- o availability of the [illegible]. Figure 9 shows the factors involved for implementing each alternative approach.

4.3.1 CABLE TEST

A cable continuity test will be performed between the north end of the known cable break and the terminal building. The purpose of the continuity test is to determine if a suspected cable fault in the vicinity of the north sandbar does or does not exist.

The north end of the cable break will be destabilized, floated to the surface, and brought aboard the construction platform by UCT-1 personnel. The cable continuity test will be performed by the WECO representative.

The sequential tasks involved in the cable continuity test are as follows:

1. Put LCM-6 in a 3 point moor*over the known cable break with the LCM-6 bow seaward. Figure 10 shows the center [illegible] moorings to the port and starboard sides of the LCM-6. These will be fastened to previously installed concrete clumps or rock bolts. The choice of either concrete clumps or rock bolts will depends on the results of a diver inspection of the bottom in the cable break area. The third mooring leg will be established over the stern of the LCM-6 by stoppering a line from the LCM-6 to the north end of the 5120 cable break.

2. Destabilize the north end of the broken cable as required by:

   - o cutting the U-rods with a hydraulic band saw

*One mooring leg will be the north end of the broken cable.

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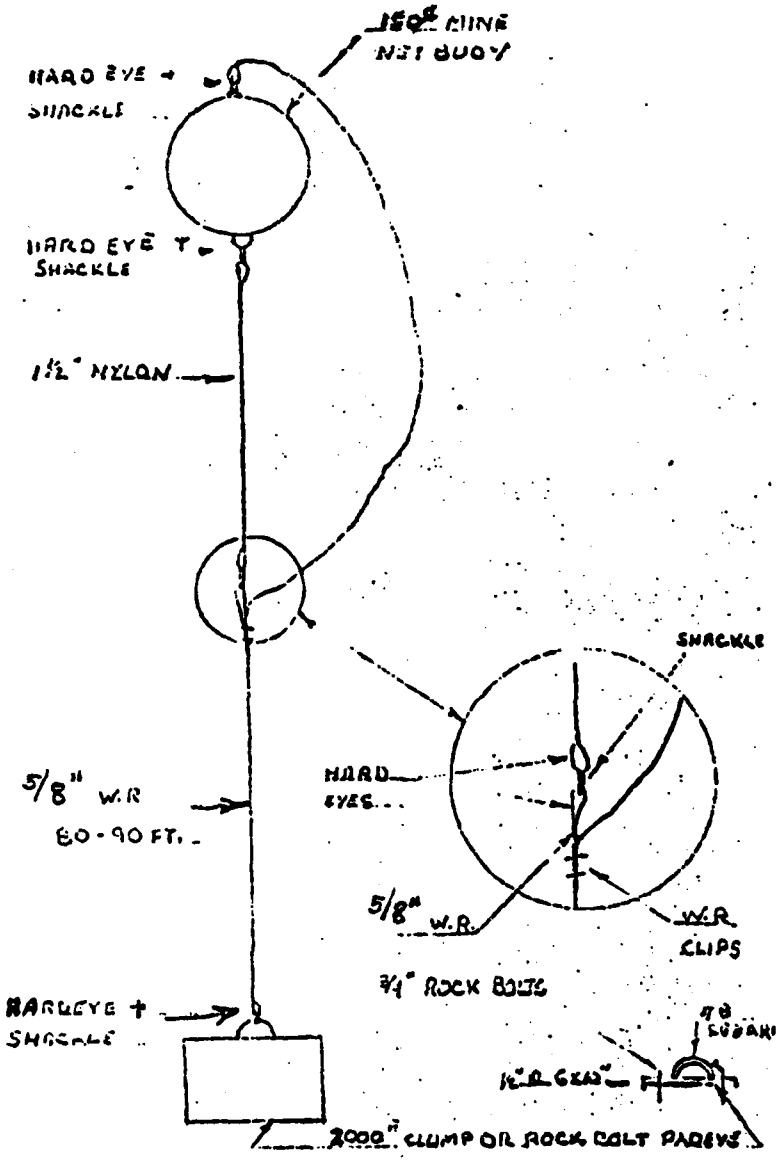

MOORING BUOYS

FIGURE 8

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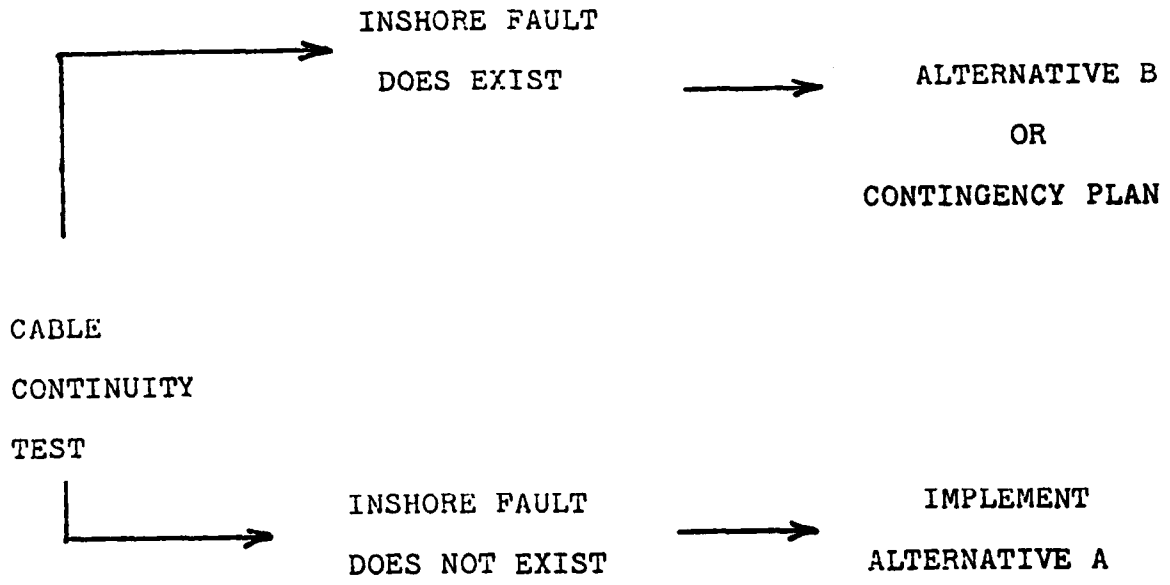

DECISION MAKING FACTORS

FIGURE 9

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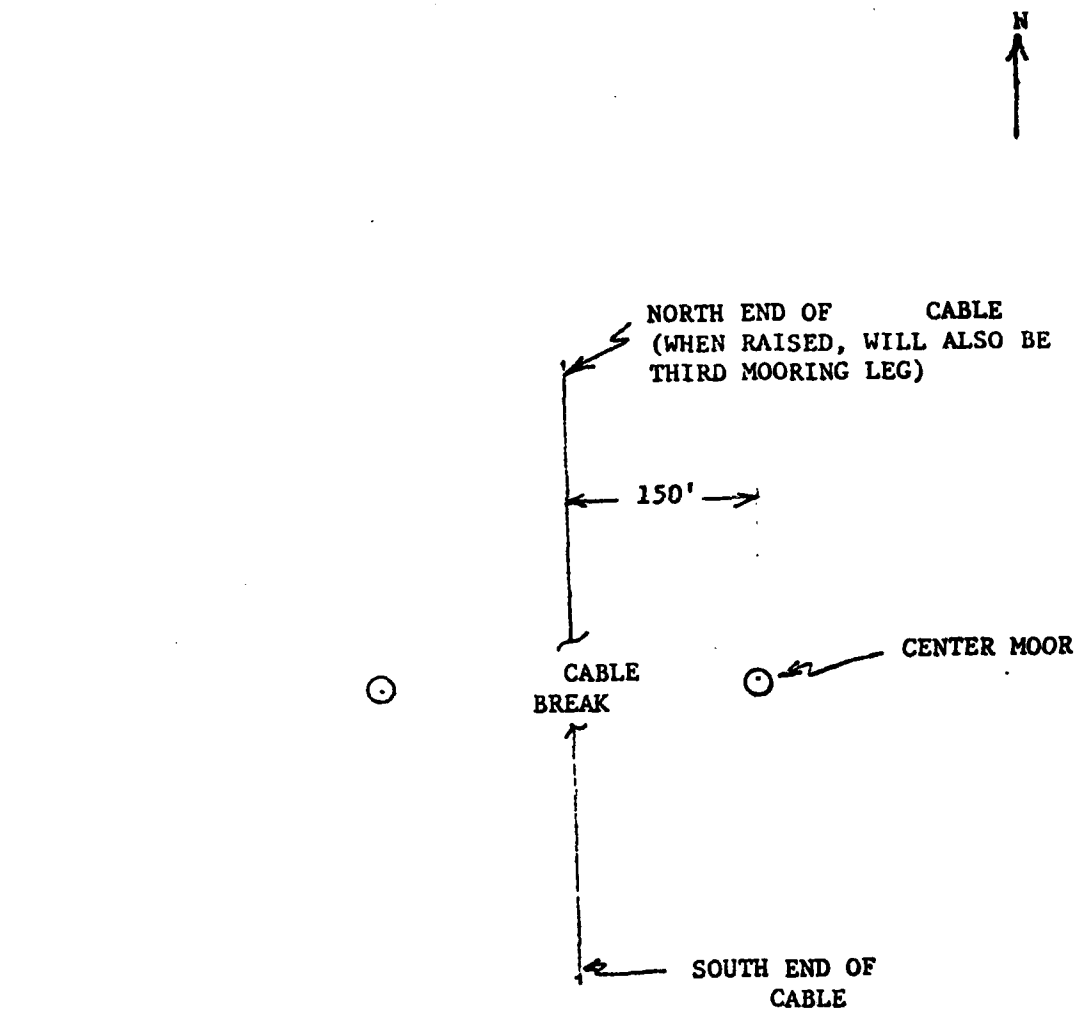

Legend

○ 2000# CLUMPS OR ROCK BOLTS

CABLE TEST - 3 POINT MOOR

FIGURE 10

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- manually unbolting rock bolts, and the split pipe flange nuts and bolts. If removal of these cannot be effected manually, either a mechanical nut splitter or grinder will be used. Utilizing the mechanical nut splitter will be the preferred method.

- remove the split pipe from the cable.

3. Place (underwater) a polypro stopper on the north end of the cable.

4. Tie balloons every 10 ft along the destabilized cable.

5. Inflate the balloons and raise the north end of the cable break to the surface.

6. Hook a messenger line from the LCM-6 onto the polypro stopper.

7. Utilizing the installed forward air tugger haul the north end of the cable over the stern roller and onboard the LCM-6.

8. When a sufficient length of cable is aboard the LCM-6 (determined by WECO rep), "horse" the cable from the stern roller into the stern chocks and secure the polypro stopper to the padeyes on the Well Deck.

9. Place a BTL stopper above the polypro stopper and secure the BTL stopper to padeyes on the Well Deck. The LCM-6 is now in a 3 point moor.

10. Remove the polypro stopper.

11. Cut off a sufficient length from the end of the cable until a point of diminished water intrusion is reached. The WECO representative will decide on the amount of cable to be cut from the end.

12. WECO representative will effect the cable continuity test.*

4.3.2 ALTERNATIVE A

Assuming no fault exists between the north end of the cable break and the terminal building, Alternative A will be implemented. This alternative entails making a single splice between the north and south end of the cable break.

*Consideration may at this time be given to repeat procedure on south end of cable.

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The sequential tasks involved in executing Alternative A are as follows:

1. Untie BTL stopper on north end of cable from padeyes on Well Deck; leave BTL stopper on cable.

2. "Horse" cable from stern chocks onto stern roller.

3. Warp LCM-6 forward, and overboard north end of cable break with BTL stopper attached; cable will be allowed to sink.*

4. Establish a 6 point moor for the LCM-6 by installing northern and southern moor pairs as shown on figure 11. Either rock bolts or clumps will be used depending on bottom condition.

5. At the same time the 6 point moor is being established, destabilize approximately 150 ft of the south end of the cable break in the same manner as for the north end; attach a polypro stopper to the end of the cable; attach balloons every 10 ft along the destabilized cable.

6. Put LCM-6 in a 4 point moor using the center and northern moorings.

7. Attach balloons every 10 ft on the bare north end of the cable break. This can be accomplished while working south end.

8. Inflate the balloons and raise the north end of the cable break to the surface.

9. Hook a messenger line from the LCM-6 onto the BTL stopper.

10. Utilizing the forward air tugger, haul the north end of the cable over the stern roller and onboard the LCM-6. Remove balloons outboard of stern roller.

11. When a sufficient length of cable is aboard the LCM-6, "horse" the cable from the stern roller into the stern chocks, and secure the BTL stopper to the padeyes on the Well Deck.

12. WECO representative will determine the amount to be cut from the north end of the cable depending on the extent of water intrusion.

13. Tie balloons every 10 ft along the repair cable on shore.

14. Place a BTL stopper over the end of the repair cable.

*At this point, the LCM-6 will be free for operations to establish a splicing moor.

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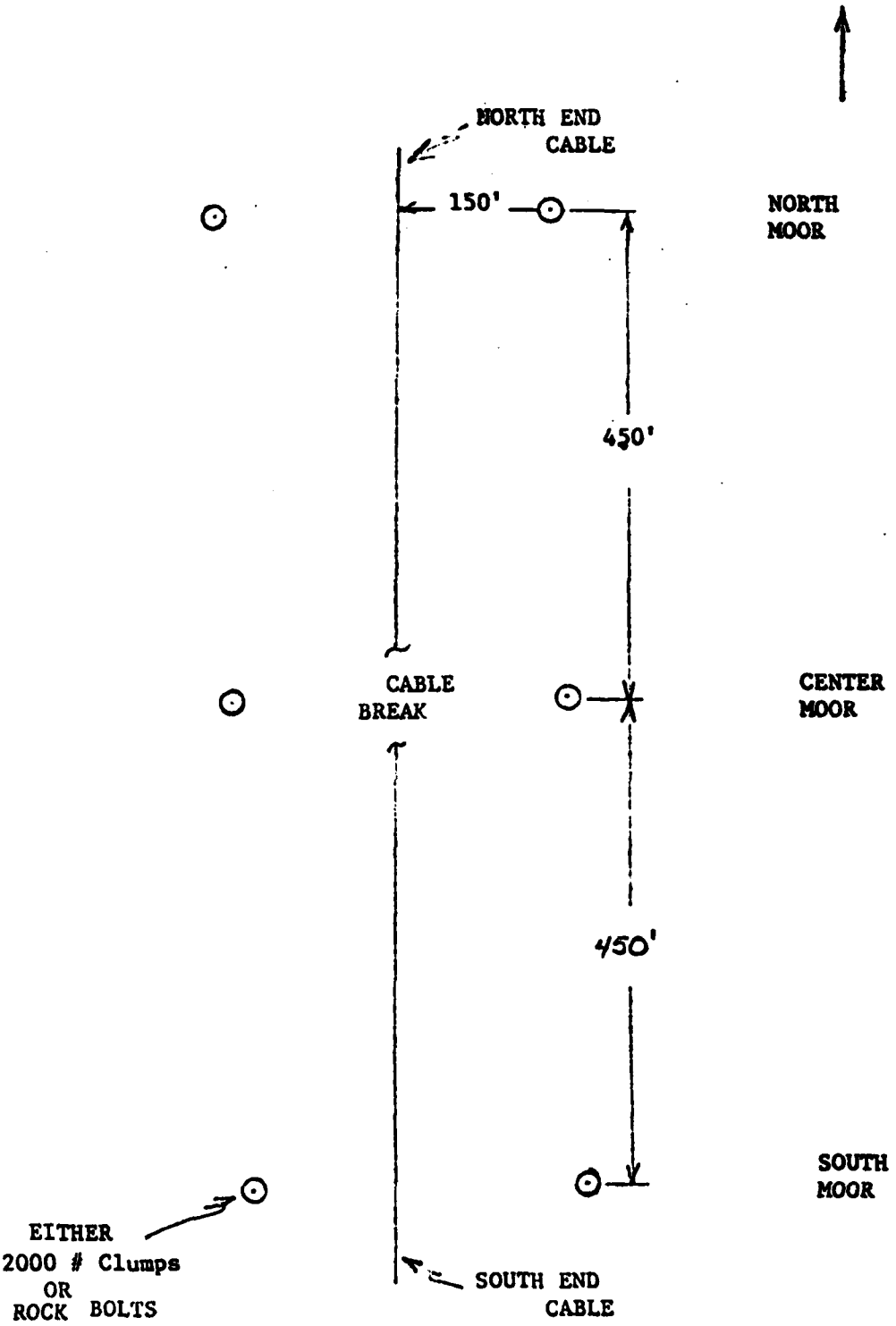

ALTERNATIVE A - 6 POINT MOOR

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FIGURE 11

15. Using the LARC-5, pull a 600 ft* section of repair cable from the beach station.

16. Hook a messenger line from the LCM-6 to the BTL stopper on the end of the repair cable.

17. Utilizing the forward air tugger, haul the repair cable over the forward roller and on board the LCM-6

18. When a sufficient length of repair cable is aboard, "horse" the repair cable from the forward roller into the forward chocks, and secure the BTL stopper on the repair cable to the padeyes on the Well Deck.

19. WECO representative will determine the length to be cut off the end of the repair cable depending upon the extent of water intrusion.

20. Erect tent.

21. Splice north end of cable to repair cable.

22. Untie spliced cable from Well Deck and "horse" into stern roller.

23. Warp LCM-6 forward allowing the spliced cable to go over the stern roller.

24. Inflate balloons attached to the south end of the cable and float cable to the surface.

25. Shift mooring lines from northern and center moors to center and southern moors; continue warping LCM-6 forward.

26. When bitter-end of the repair cable is aboard LCM-6 secure the repair cable to the padeyes on the Well Deck.

27. Attach a messenger line to the polypro stopper on the south end

28. Utilizing the forward air tugger haul the south end of the cable over the forward roller and onboard the LCM-6. Remove balloons outboard of forward roller.

29. When a sufficient length of the south end of the cable is aboard the LCM-6 "horse" the cable from the forward roller into the forward chocks and secure polypro stopper to padeyes on Well Deck.

*Length may be extended subject to south end cable test.

30. Attach a BTL stopper to the cable and secure it to padeyes; remove polypro stopper.

31. WECO representative will determine the amount of cable to be cut from the LPJ repair link and from the south end of the cable.

32. WECO representative will acoustically test the south end and then splice south end of cable to the LPJ repair cable.

33. Free BTL stopper from padeyes and "horse" cable from forward chocks and place in bow trough.

34 Install split pipe on cable and feed split pipe over bow trough while warping LCM-6 to stern; two bellmouth ends of split pipe are welded together and the resulting additional space within the pipe is placed to accommodate the larger diameter at the point of the splice.

35. As cable comes over bow trough into the water attach an inflated balloon every 3 ft.

36. Continue warping down LCM-6 and installing split pipe until north section of cable approaches the bend radius of the cable (15'); WECO rep will make the determination regarding bend radius.

37. Stop LCM-6, remove cable from the stern roller and bow trough.

38. "Horse" cable over portside of LCM-6.

39. Slit every other inflated balloon*such that the cable is lowered slowly; position cable on bottom by pulling submerging cable in a westerly direction with 2 small crafts.**

40. Install split pipe on submerged bare cable;add end-configurations and lengths of split pipe will be fabricated on site by cutting the standard pipe sections to the required lengt and welding the cut parts together orienting end-configurations as appropriate (welding to be effected in accordance with Appendix

41. For cable immobilization on rock bottom:

    a) remove split pipe flange nuts and bolts on the opposite sides of every sixth pipe section. The exact nuts and bolts to be removed are shown in figure 12.

*Caution, avoid domino effect.
**Hold catenary with small boat-do not rely on wind to hold catenary.

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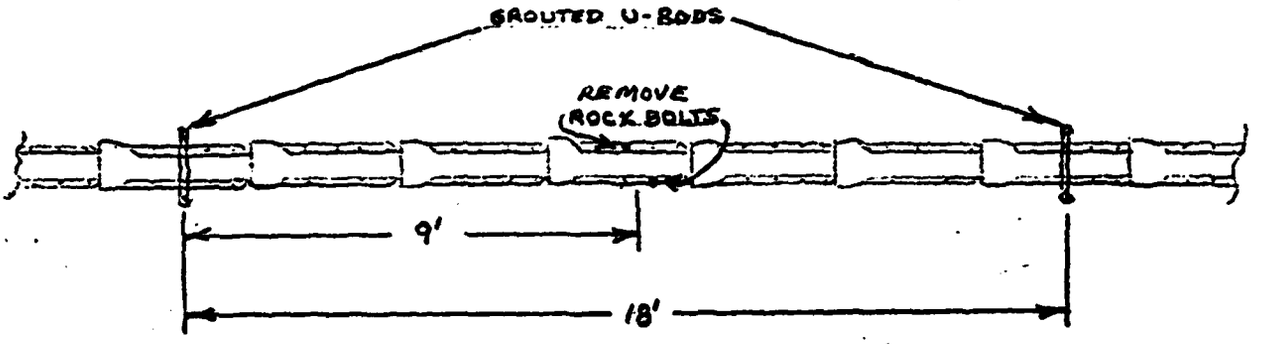

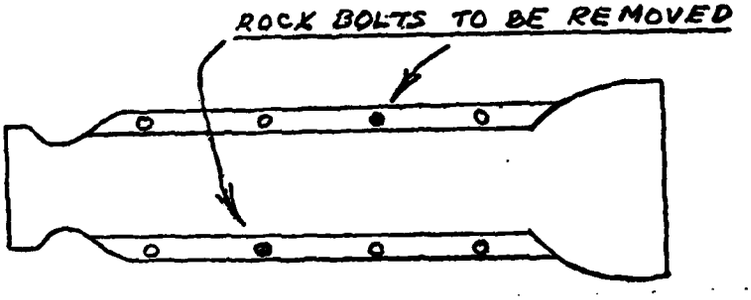

SPLIT PIPE STABILIZATION

FIGURE 12

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- o Nuts and bolts should not be removed near the bell-mouth section of the pipe.

b) with the holes in the pipe flange as a guide, use a rock drill to drill 5/8" diameter, 6"-8" deep holes in the rock.

c) install rock bolts in the drilled holes and tap the rock bolts into the rock with a 3 lb. Sledge hammer.

d) screw the rock bolt nut onto the exposed portion of the rock bolt and tighten the nut to 80 ft-lbs with a torque wrench.

e) in a similar manner, install rock bolts in every sixth pipe section along the length of the repaired section.

f) install U-rods along the length of the repaired cable by drilling 2-1/4" diameter holes, 18" deep on opposite sides of the split pipe. The holes will be drilled using the drill jig shown in figure 13, every 18 feet.

g) place U-rods over split pipe and fasten in drilled holes filled with grout. The grout will be mixed in the proportion three quarts of cement to thirty-three ounces of water. The grout will be mixed in polyethylene tubing onboard the LCM-6 and sent down on a messenger line to the divers installing the U-rods.

42. Inspect the entire repair cable section for stability.

43. Inspect entire cable, and where necessary replace U-rods and rock bolts.

4.3.3 ALTERNATIVE B

Alternative B considers that the cable test confirms that an inshore cable fault exists and the USNS will be permitted to enter waters. The cable repair will be effected by a single splice between the south end of the known cable break and the north end of the measured cable fault position. Figure 14 shows schematically the repair cable spliced into the cable.

The sequential tasks to execute Alternative B are as follows:

1. Prepare beach station for repair cable landing as follows:

- o have 2 bulldozers on hand

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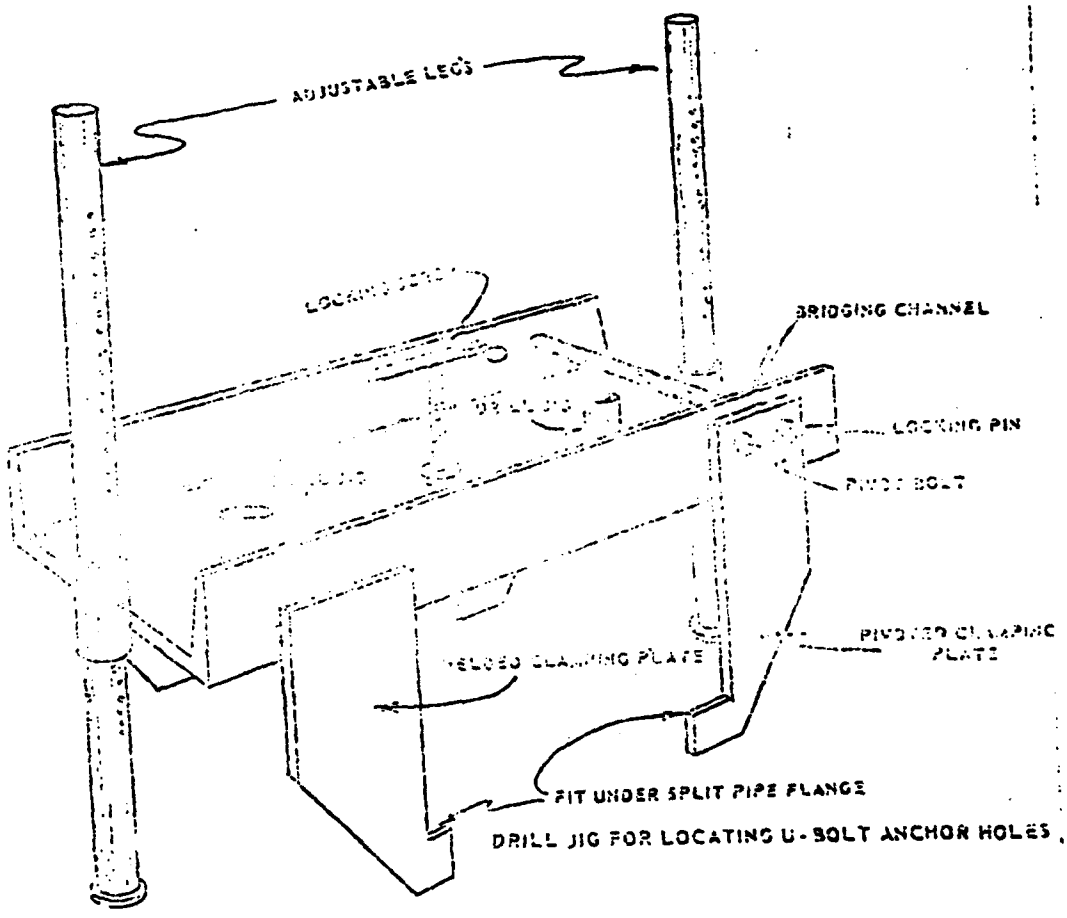

DRILL JIG FOR LOCATING U-ROD ANCHOR HOLES

FIGURE 13

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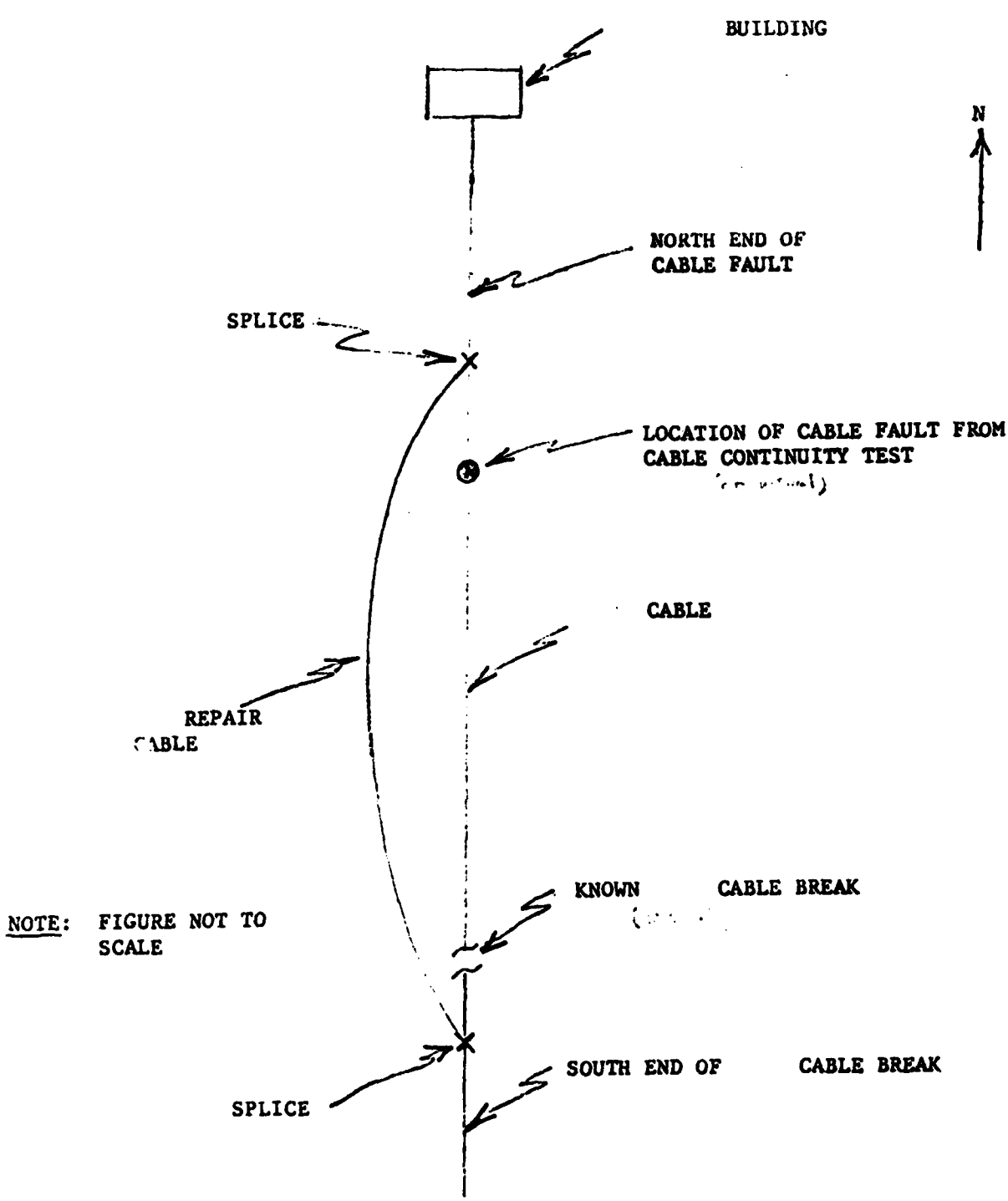

ALTERNATIVE B SPLICING

FIGURE 14

- o install 2 poles to fairlead a messenger line from the repair cable to a bulldozer on land in a 195° bearing
- o additional beach leveling as required

Furthermore, place two rock bolts at suitable locations on the seafloor at the southern end of the projected repair cable section. These rock bolts will serve to anchor the cable when the cable ship departs the area. Mark the rock bolts with floats.

2. Cable ship arrives and moors in line with range lights on beach and south of the cable break.
3. LARC-5 takes messenger line from beach station to cable ship.
4. Cable ship personnel attach a BTL stopper to the end of the repair cable; attach the repair cable to the messenger line, and overboard repair cable tieing balloons to the repair cable every 10 ft. With messenger line attached by a chain stopper or a rat-tail stopper, the bulldozer on the beach hauls the repair cable towards shore.
5. Haul sufficient repair cable towards shore to pass the north end of the cable fault by at least 300 feet.
6. At a selected section along the repair cable, cable ship personnel will attach 2 BTL stoppers, These stoppers will serve to anchor the southern end of the repair cable to the two rock bolts previously installed for this purpose. The location of the stoppers will be selected such that this anchoring may be effected.
7. Moor the repair cable to the bottom by attaching mooring lines from the rock bolts to the 2 BTL stoppers.
8. Sink the repair cable by deflating every other balloon.
9. Cable ship personnel will raise the south end of the cable break. (if so, destabilizing will be required)
10. WECO representative aboard the cable ship will effect an acoustic test of the south end and then splice between the repair cable and the south end of the cable break.
11. Cable ship personnel will overboard the spliced section.
12. Cable ship departs.

13. Establish a four-point moor above the position where the cable exits the sandbar north of the measured fault (figure 15). Place the LCM-6 in the moor bow shoreward.

14. Destabilize the cable north of the measured cable fault over a distance 150 feet from the point where the cable exits the sandbar. Destabilization is effected by:

    - o cutting the U-rods with hydraulic band saw
    - o manually unbolting rock bolts, and the split pipe flange nuts and bolts. If removal of these cannot be effected manually, either a mechanical nut splitter or grinder will be used. Utilizing the mechanical nut splitter will be the preferred method.
    - o remove the split pipe from the cable

15. Cut the cable at the position of accessibility and place a polypro stopper on the inshore side of the cut.

16. Tie balloons every 10 ft along the destabilized cable.

17. Inflate the balloons and raise the destabilized cable section to the surface.

18. Hook a messenger line from the LCM-6 onto the polypro stopper.

19. Utilizing the installed forward air tugger haul the north end of the cable over the forward roller and on board the LCM-6. Remove balloons outboard of forward roller.

20. When a sufficient length of cable is aboard the LCM-6, "horse" the cable from the forward roller into the forward chock and secure the polypro stopper to the padeyes on the Well Deck.

21. Place a BTL stopper above the polypro stopper and secure the BTL stopper to padeyes on the Well Deck.

22. Remove the polypro stopper.

23. Cut off a sufficient length from the end of the cable until a point of diminished water intrusion is reached. The WECO representative will decide on the amount of cable to be cut from the end.

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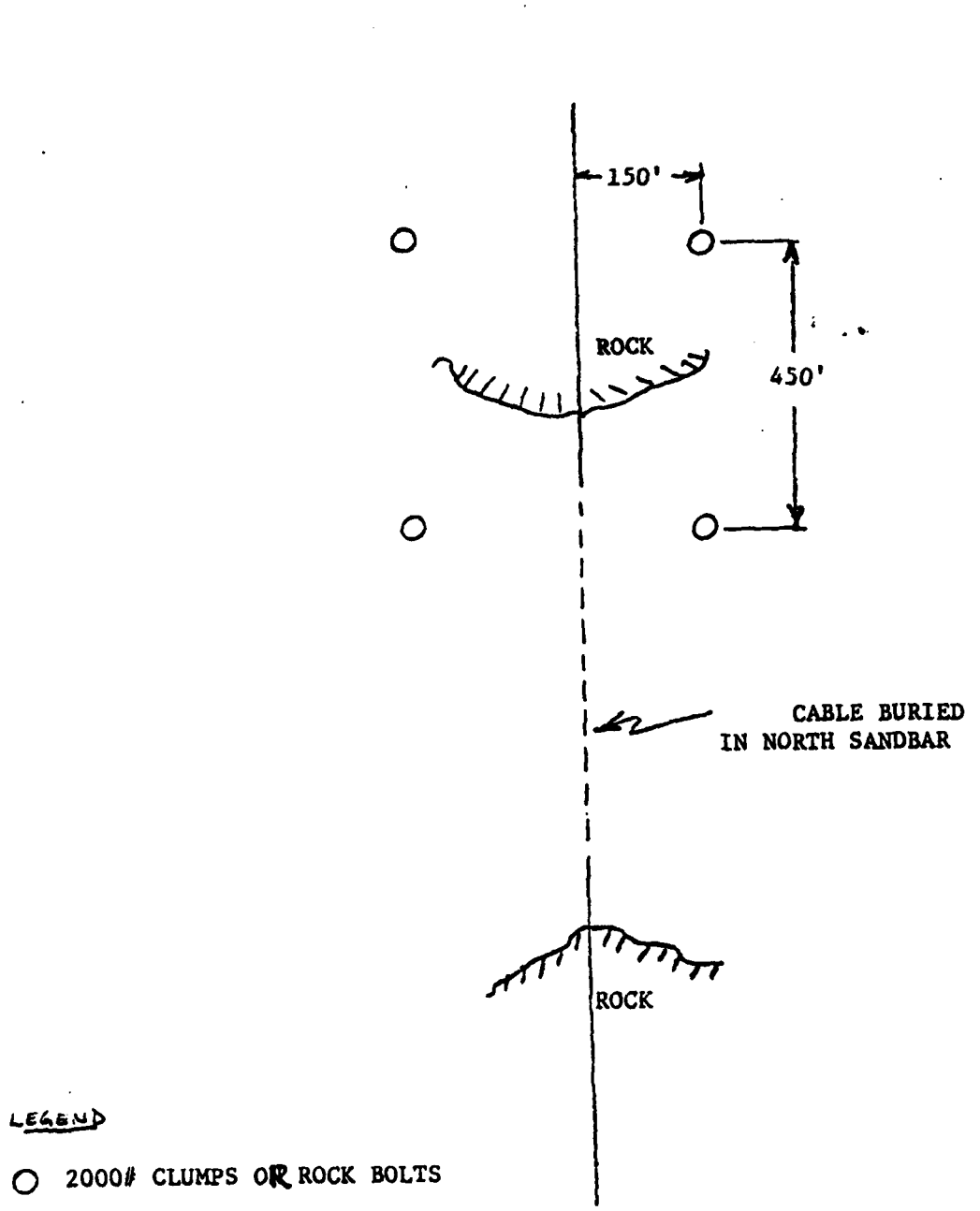

ALTERNATIVE B - LCM-6 4 POINT MOOR

FIGURE 15

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24. Back down the bulldozer thus slackening the messenger line to the repair cable. Remove this messenger line from the BTL stopper on the repair cable and replace it with another messenger line passed over the stern roller of the LCM-6 and to the forward air tugger.

25. Reinflate balloons on the repair cable and float it to the surface.

26. Haul the repair cable board the LCM-6; remove balloons outboard of stern roller.

27. When a sufficient length of repair cable is aboard, "horse" the repair cable from the stern roller into the stern chocks, move the BTL stopper further up on the repair cable and secure cable to the padeyes on the Well Deck.

28. WECO representative will determine the length to be cut off the end of the repair cable depending upon the extent of water intrusion.

29. Erect tent.

30. Splice shoreward section of cable to repair cable.

31. Untie spliced cable from Well Deck and "horse" into stern roller and into bow trough.

32. Install split pipe on cable and feed cable with split pipe over bow trought while warping LCM-6 to stern; two bellmouth ends of split pipe are welded together and the resulting additional space within the pipe is placed to accommodate the larger diameter at the point of the splice.

33. As cable and split pipe comes over bow trough into the water attach inflated balloons every 3 ft.

34. Continue to warp LCM-6 to stern installing split pipe. Two LARC-5's will function as "warping tugs" to stabilize the LCM-6 as it warps to stern. The LCM-6 will warp down until the minimum bend radius of the cable is approached at the southern end of the repair section. WECO rep will make the determination regarding the bend radius. Radio communication between WECO rep, LCM-6 pilot, and LARC-5 pilots will be maintained during this entire operation.

35. "Horse" cable over portside of LCM-6.

36. Slit every other inflated balloon such that cable is lowered slowly; position cable on bottom by pulling submerging cable in westerly direction with two small craft.

37. Install split pipe on submerged bare cable; odd end-configurations and lengths of split pipe will be fabricated on site by cutting the standard pipe sections to the required length and welding the cut parts together orienting end configurations as appropriate (welding to be effected in accordance with Appendix D).

38. For cable immobilization on rock bottom:

    a) remove split pipe flange nuts and bolts on the opposite sides of every sixth pipe section. The exact nuts and bolts to be removed are shown in figure 16.

        o Nuts and bolts should not be removed near the bell-mouth section of the pipe.

    b) with the holes in the pipe flange as a guide, use a rock drill to drill 5/8" diameter, 6"-8" deep holes in the rock.

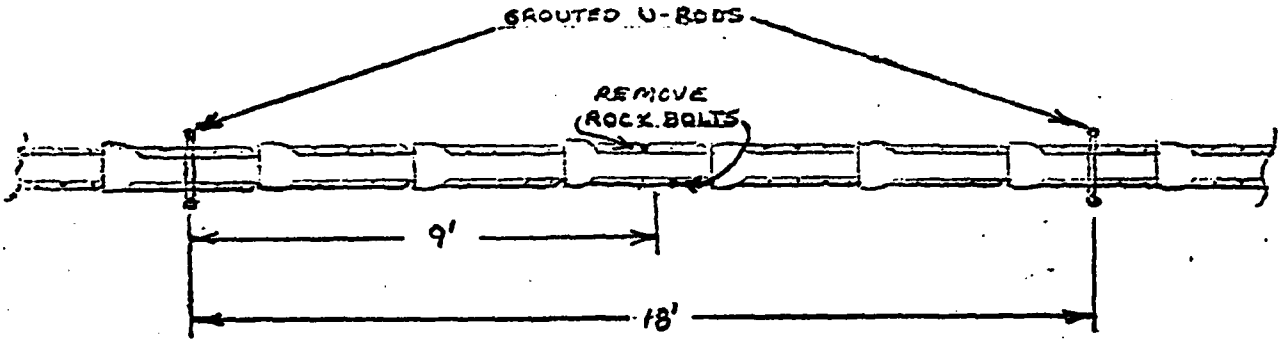
    c) install rock bolts in the drilled holes and tap the rock bolts into the rock with a 3 lb. sledge hammer.

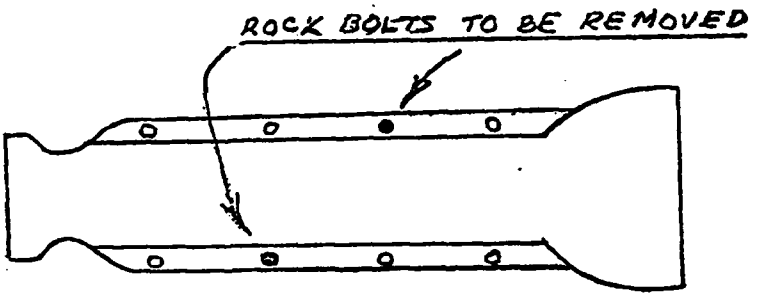
    d) screw the rock bolt nut onto the exposed portion of the rock bolt and tighten the nut to 80 ft-lbs with a torque wrench.

    e) in a similar manner, install rock bolts in every sixth pipe section along the length of the repaired section.

    f) install U-rods along the length of the repaired cable by drilling 2-1/4" diameter holes, 18" deep on opposite sides of the split pipe. The holes will be drilled every 18 feet using the drill jig shown in Figure 17.

    g) place U-rods over split pipe and fasten in drilled holes filled with grout. The grout will be mixed in the proportion three quarts of cement to thirty-three ounces of water. The grout will be mixed in polyethylene tubing onboard the LCM-6 and sent down on a messenger line to the divers installing the U-rods.





SPLIT PIPE STABILIZATION

FIGURE 16

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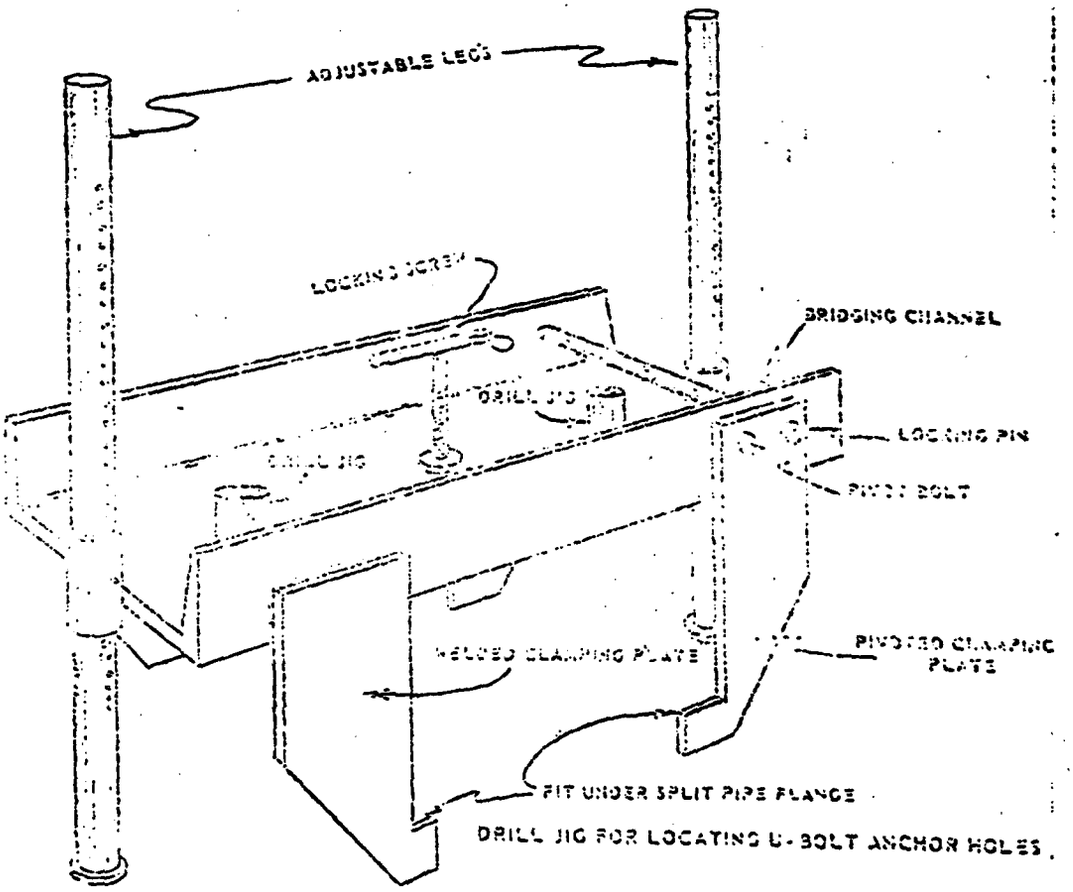

DRILL JIG FOR LOCATING U-ROD ANCHOR HOLES

FIGURE 17

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No immobilization is required on sandy bottom.

39. Inspect the entire repair cable section for stability.

40. Inspect entire protected and immobilized portion of the cable and where necessary replace U-rods and rock bolts.

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4.3.4 Contingency Plan

This contingency plan covers the event where the cable test confirms that an inshore cable fault exists and the cable ship will not be permitted to enter the site. The cable repair will be effected by a splice between the south end and the north end of the known cable break and a second splice bypassing the inshore cable fault. Figure 18 shows the splice at the known cable break and the second splice bypassing the inshore cable fault.

The sequential tasks involved in executing this contingency plan are as follows:

1. Upon completion of the cable test, at the known cable break, and with the section north of the fault still on-board the LCM-6, untie BTL stopper on the cable from padeyes on Well Deck; leave BTL stopper on cable.

2. "Horse" cable from stern chocks onto stern roller.

3. Warp LCM-6 forward, and overboard north end of cable break with BTL stopper attached; cable will be allowed to sink.*

4. Establish a 6 point moor for the LCM-6 by installing northern and southern moor pairs as shown on figure 19. Either rock bolts or clumps will be used depending on bottom condition.

5. At the same time the 6 point moor is being established, destabilize approximately 150 ft to the south of the cable break in the same manner as for the north end; attach a polypro stopper to the end of the cable; attach balloons every ten ft. along the destabilized cable.

6. Put LCM-6 in a 4 point moor bow seaward using the center and northern moorings.

7. Attach balloons every 10 ft on the bare cable section north of the cable break. This can be accomplished while working south end.

8. Inflate the balloons and raise the north end of the cable break to the surface.

*At this point, the LCM-6 will be free for operations to establish a splicing moor.

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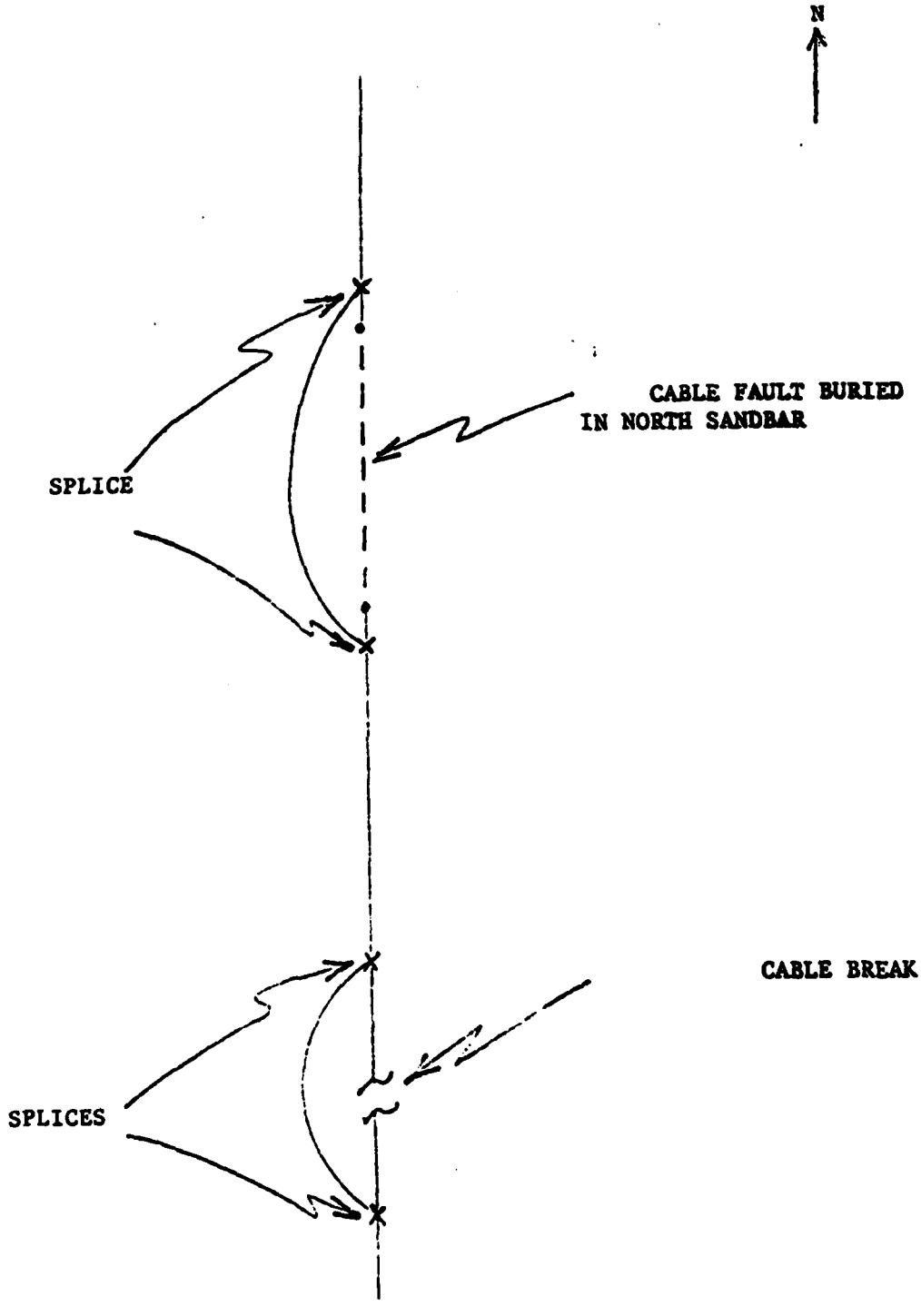

CONTINGENCY PLAN REPAIR SPLICES

FIGURE 18

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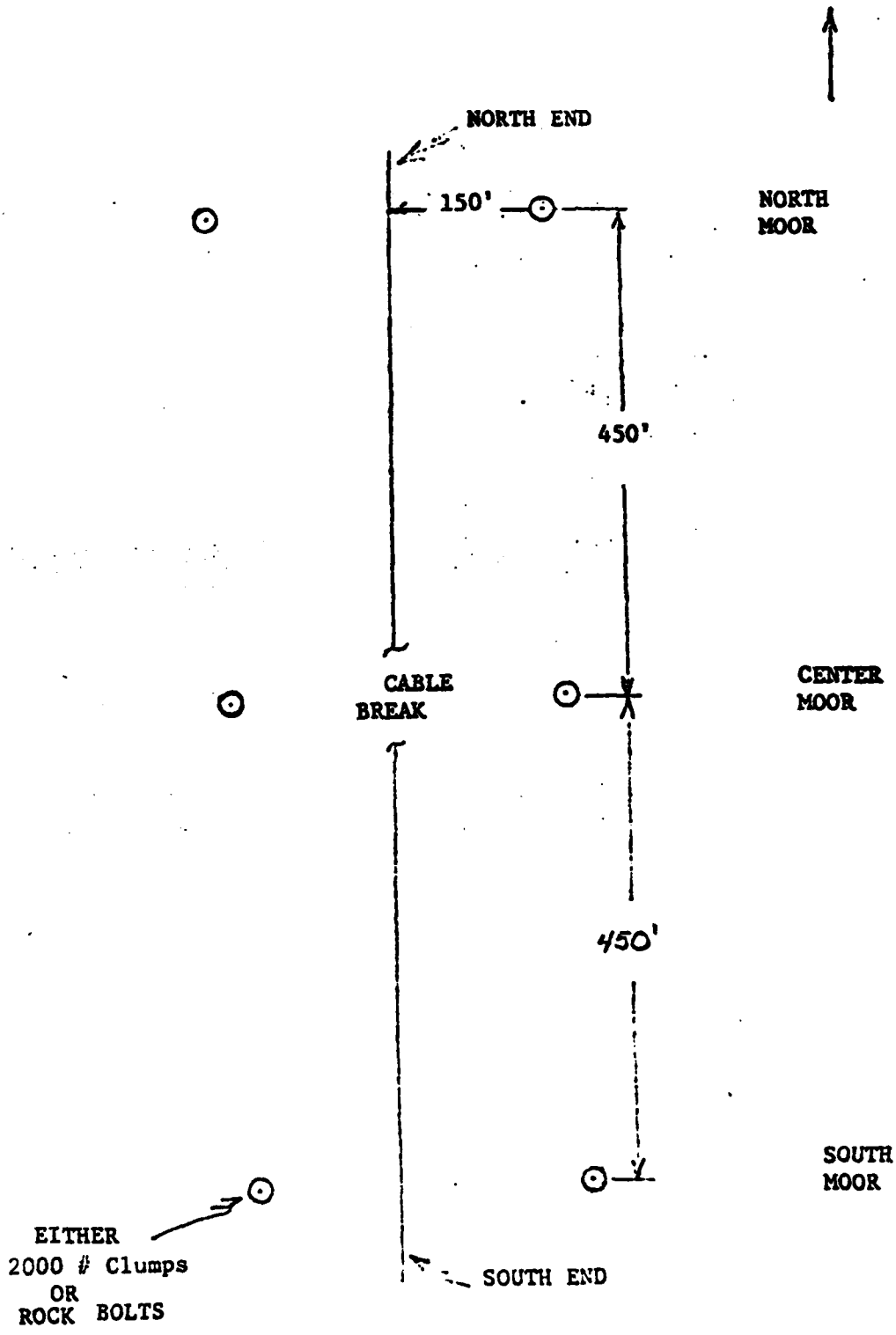

6 POINT MOOR

FIGURE 17

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9. Hook a messenger line from the LCM-6 onto the BTL stopper.

10. Utilizing the forward air tugger, haul the north end of the cable over the stern roller and onboard the LCM-6. Remove balloons outboard of stern roller.

11. When a sufficient length of cable is aboard the LCM-6, "horse" the cable from the stern roller into the stern chocks, and secure the BTL stopper to the padeyes on the Well Deck.

12. WECO representative will determine the amount to be cut from the north end of the cable depending on the extent of water intrusion.

13. Tie balloons every 10 ft along the repair cable on shore.

14. Place a BTL stopper over the end of the repair cable.

15. Using the LARC-5, pull a 600 ft* section of repair cable from the beach station.

16. Hook a messenger line from the LCM-6 to the BTL stopper on the end of the repair cable.

17. Utilizing the forward air tugger, haul the repair cable over the forward roller and on board the LCM-6

18. When a sufficient length of repair cable is aboard, "horse" the repair cable from the forward roller into the forward chocks, and secure the BTL stopper on the repair cable to the padeyes on the Well Deck.

19. WECO representative will determine the length to be cut off the end of the repair cable depending upon the extent of water intrusion.

20. Erect tent.

21. Splice north end of cable to repair cable.

22. Untie spliced cable from Well Deck and "horse" into stern roller.

*Length may be extended subject to south end cable test.

Tie off shorter end of repair cable to South mooring to hold in position

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23. Warp LCM-6 forward allowing the spliced cable to go over the stern roller.

24. Inflate balloons attached to the south end of the cable and float cable to the surface.

25. Shift mooring lines from northern and center moors to center and southern moors; continue warping LCM-6 forward.

26. When bitter-end of the repair cable is aboard LCM-6 secure the repair cable to the padeyes on the Well Deck.

27. Attach a messenger line to the polypro stopper on the south end

28. Utilizing the forward air tugger haul the south end of the cable over the forward roller and onboard the LCM-6. Remove balloons outboard of forward roller.

29. When a sufficient length of the south end of the cable is aboard the LCM-6 "horse" the cable from the forward roller into the forward chocks and secure polypro stopper to padeyes on Well Deck.

30. Attach a BTL stopper to the cable and secure it to padeyes; remove polypro stopper.

31. WECO representative will determine the amount of cable to be cut from the repair link and from the south end of the cable.

32. WECO representative will acoustically test the south end and then splice south end of cable to the repair cable.

33. Free BTL stopper from padeyes and "horse" cable from forward chocks and place in bow trough.

34 Install split pipe on cable and feed split pipe over bow trough while warping LCM-6 to stern; two bellmouth ends of split pipe are welded together and the resulting additional space within the pipe is placed to accommodate the larger diameter at the point of the splice.

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35. As ~~cable comes~~ split pipe goes over bow trough into the water attach an inflated balloon every 3 ft.

36. Continue warping down LCM-6 and installing split pipe until north section of cable approaches the bend radius of the cable (15'); WECO rep will make the determination regarding bend radius.

37. Stop LCM-6, remove cable from the stern roller and bow trough.

38. "Horse" cable over portside of LCM-6.

39. Slit every other inflated balloon* such that the cable is lowered slowly; position cable on bottom by pulling submerging cable in a westerly direction with 2 small crafts.**

40. Install split pipe on submerged bare cable; odd end-configurations and lengths of split pipe will be fabricated on site by cutting the standard pipe sections to the required len and welding the cut parts together orienting end-configurations as appropriate (welding to be effected in accordance with Appendi

41. For cable immobilization on rock bottom:

    a) remove split pipe flange nuts and bolts on the opposite sides of every sixth pipe section. The exact nuts and bolts to be removed are shown in figure 20.

       o Nuts and bolts should not be removed near the bell-mouth section of the pipe.

    b) with the holes in the pipe flange as a guide, use a rock drill to drill 5/8" diameter, 6"-8" deep holes in the rock.

    c) install rock bolts in the drilled holes and tap the rock bolts into the rock with a 3 lb. sledge hammer.

    d) screw the rock bolt nut onto the exposed portion of the rock bolt and tighten the nut to 80 ft-lbs with a torque wrench.

    e) in a similar manner, install rock bolts in every sixth pipe section along the length of the repaired section.

*Caution, avoid domino effect.
**Hold catenary with small boat-do not rely on wind to hold catenary.

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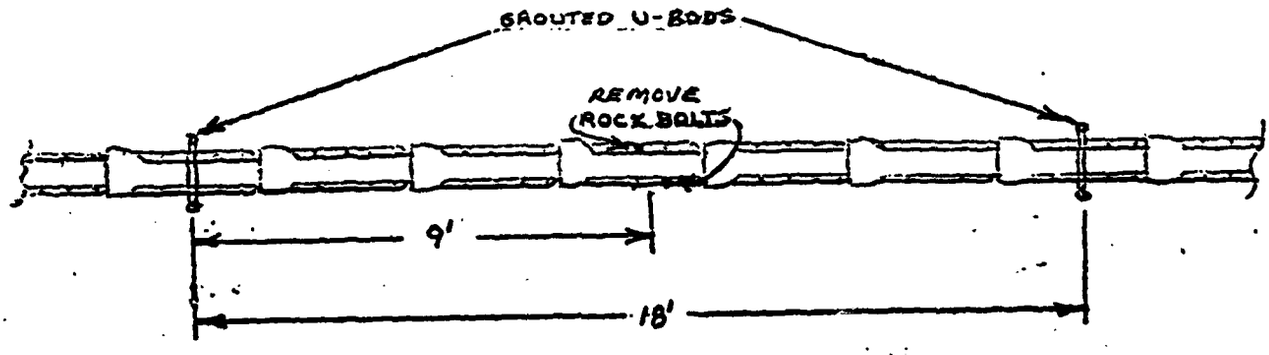

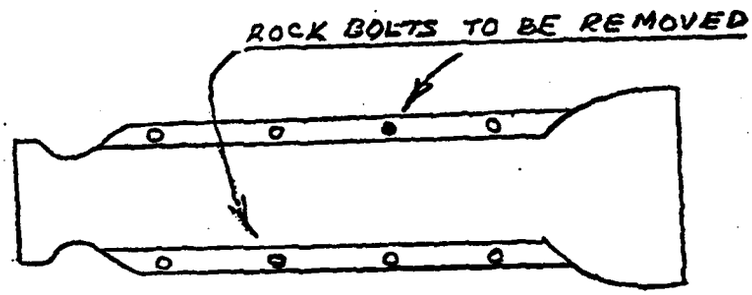

SPLIT PIPE STABILIZATION

FIGURE 20

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f) install U-rods along the length of the repaired cable by drilling 2-1/4" diameter holes, 18" deep on opposite sides of the split pipe. The holes will be drilled every 18 feet using the drill jig shown in figure 21.

g) place U-rods over split pipe and fasten in drilled holes filled with grout. The grout will be mixed in the proportion three quarts of cement to thirty-three ounces of water. The grout will be mixed in polyethylene tubing onboard the LCM-6 and sent down on a messenger line to the divers installing the U-rods.

42. Inspect the entire repair cable section for stability.

The splice between the south end and the north end of the known cable break is now complete.

The sequential tasks involved in executing the inshore cable repair are as follows:

43. Establish a 6 point moor for the LCM-6 over the measured in-shore fault as shown in figure 22.

44. Put LCM-6 in a 2 point moor, bow seaward, using the center moor.

45. Destabilize the cable north and south of the measured cable fault over a distance of 150 feet from the point where the cable exits the sandbar. Destabilization is effected by:

- o cutting the U-rods with hydraulic band saw
- o manually unbolting rock bolts, and the split pipe flange nuts and bolts. If removal of these cannot be effected manually, either a mechanical nut splitter or grinder will be used. Utilizing the mechanical nut splitter will be the preferred method.
- o remove the split pipe from the cable

46. Cut the cable at the positions of accessibility where the cable exits the north and south sides of the north sandbar.

47. Place (underwater) a polypro stopper on each of the cut and destabilized sections of cable.

48. Tie balloons every 10 ft along both destabilized sections of cable.

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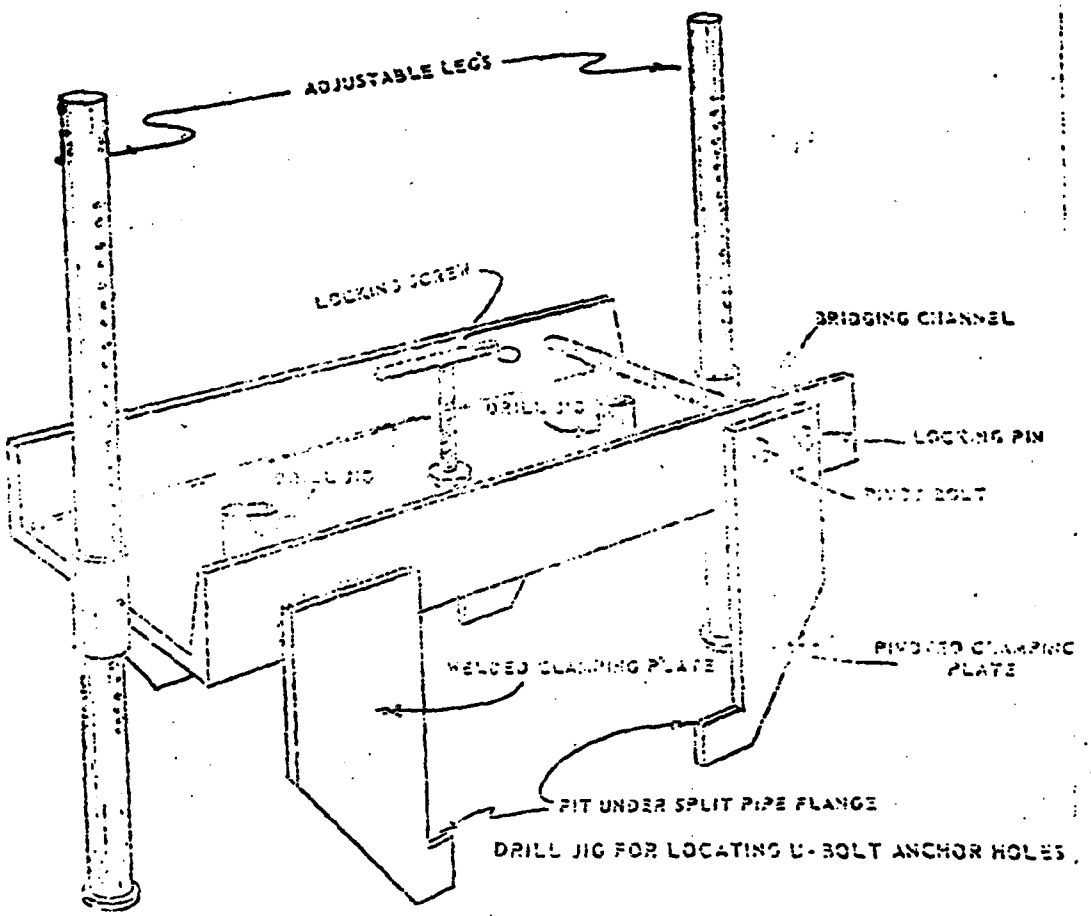

DRILL JIG FOR LOCATING U-ROD ANCHOR HOLES

FIGURE 21

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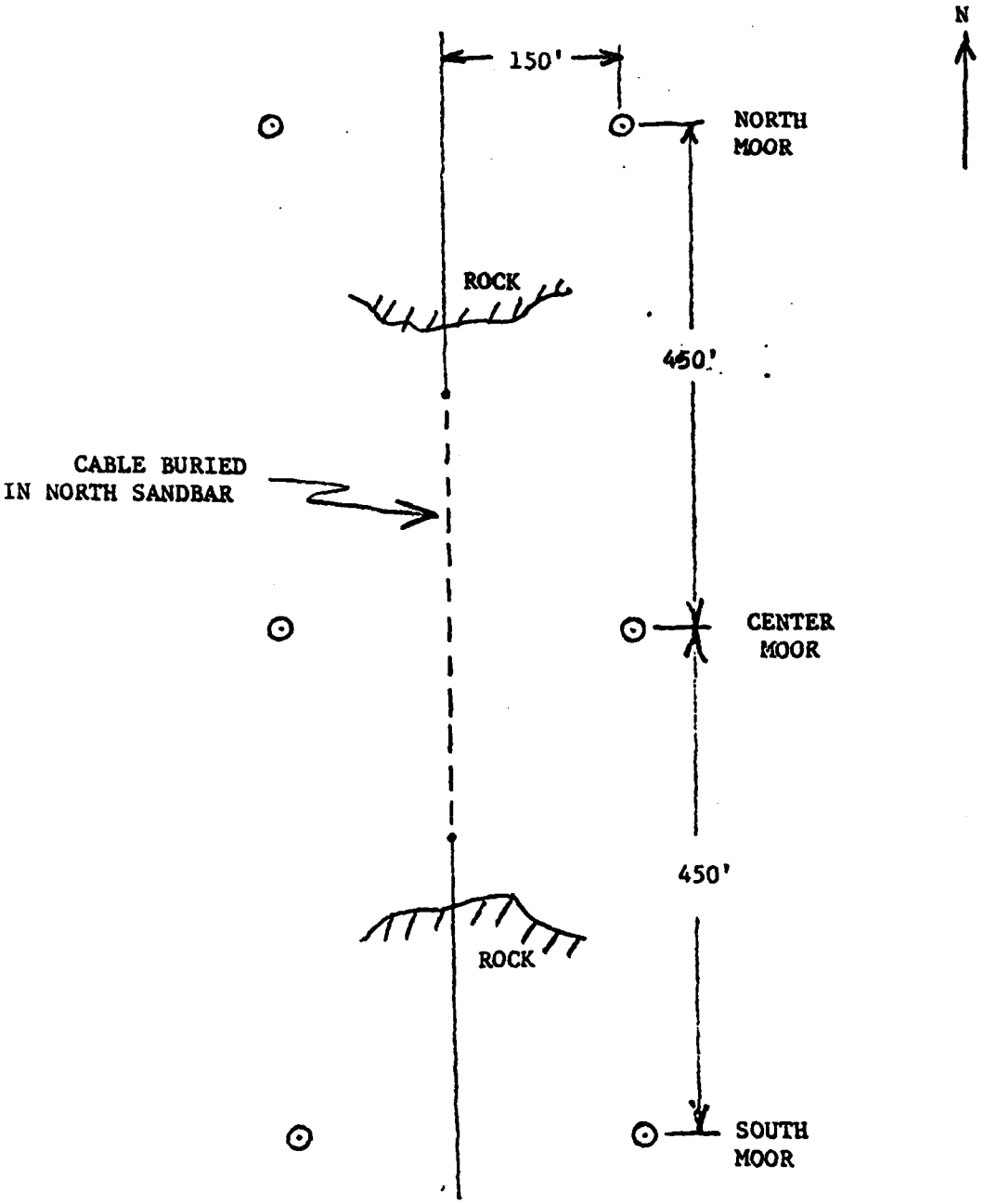

Legend:

⊙ 2000# CLUMPS OR ROCK BOLTS

INSHORE CABLE REPAIR LCM-6 MOOR

FIGURE 22

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49. Inflate the balloons on the destabilized cable north of the measured cable fault; raise destabilized cable section to the surface.

50. Put LCM-6 in a 4 point moor, bow seaward, using the center and northern moorings.

51. Hook a messenger line from the LCM-6 onto the polypro stopper.

52. Utilizing the forward air tugger, haul the north end of the cable over the stern roller and onboard the LCM-6; remove balloons outboard of stern roller as the cable is hauled aboard.

53. When a sufficient length of cable is aboard the LCM-6, "horse" the cable from the stern roller into the stern chocks and secure the polypro stopper to the Well Deck; place a BTL stopper above the polypro stopper and secure the BTL stopper to the Well Deck; remove polypro stopper.

54. WECO representative will determine the amount to be cut from the north end of the cable depending on the extent of water intrusion.

55. Tie balloons every 10 ft. along the repair cable on shore.

56. Place a BTL stopper over the end of the repair cable.

57. Using the LARC-5, pull a 1000 ft section of repair cable from the beach station.

58. Hook a messenger line from the LCM-6 to the BTL stopper on the end of the repair cable.

59. Utilizing the forward air tugger, haul the repair cable over the forward roller and on board the LCM-6

60. When a sufficient length of repair cable is aboard, "horse" the repair cable from the forward roller into the forward chocks, and secure the BTL stopper on the repair cable to the padeyes on the Well Deck.

61. WECO representative will determine the length to be cut off the end of the repair cable depending upon the extent of water intrusion.

62. Erect tent.

63. Splice north end of cable to repair cable.

64. Untie spliced cable from Well Deck and "horse" into stern roller.

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65. Warp LCM-6 forward allowing the spliced cable to go over the stern roller.

66. Shift mooring lines from northern and center moors to center and southern moors; continue warping LCM-6 forward.

67. When bitter-end of the repair cable is aboard LCM-6 or when position of the cut south end of is reached, secure the repair cable to the padeyes on the Well Deck.

68. Attach a messenger line to the polypro stopper on the south end

69. Inflate balloons attached to the south end of the cable and float cable to the surface.

70. Utilizing the forward air tugger haul the south end of the cable over the forward roller and onboard the LCM-6. Remove balloons outboard of forward roller.

71. When a sufficient length of the south end of the cable is aboard the LCM-6 "horse" the cable from the forward roller into the forward chocks and secure polypro stopper to padeyes on Well Deck.

72. Attach a BTL stopper to the cable and secure it to padeyes; remove polypro stopper.

73. WECO representative will determine the amount of cable to be cut from the repair link and from the south end of the cable.

74. WECO representative will acoustically test the south end and then splice south end of cable to the repair cable.

75. Free BTL stopper from padeyes and "horse" cable from forward chocks and place in bow trough.

76. Install split pipe on cable and feed split pipe over bow trough while warping LCM-6 to stern; two bellmouth ends of split pipe are welded together and the resulting additional space within the pipe is placed to accommodate the larger diameter at the point of the splice.

77. As ~~cable comes~~ pipe goes over bow trough into the water attach an inflated balloon every 3 ft.

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78. Continue warping down LCM-6 and installing split pipe until north section of cable approaches the bend radius of the cable (15'); WECO rep will make the determination regarding bend radius.

79. Stop LCM-6, remove cable from the stern roller and bow trough.

80. "Horse" cable over portside of LCM-6.

81. Slit every other inflated balloon*such that the cable is lowered slowly; position cable on bottom by pulling submerging cable in a westerly direction with 2 small crafts.**

82. Install split pipe on submerged bare cable; odd end-configurations and lengths of split pipe will be fabricated on site by cutting the standard pipe sections to the required le and welding the cut parts together orienting end-configurations as appropriate (welding to be effected in accordance with Append

83. For cable immobilization on rock bottom:

a) remove split pipe flange nuts and bolts on the opposite sides of every sixth pipe section. The exact nuts and bolts to be removed are shown in figure 20.

- o Nuts and bolts should not be removed near the bell-mouth section of the pipe.

b) with the holes in the pipe flange as a guide, use a rock drill to drill 5/8" diameter, 6"-8" deep holes in the rock.

c) install rock bolts in the drilled holes and tap the rock bolts into the rock with a 3 lb. sledge hammer.

d) screw the rock bolt nut onto the exposed portion of the rock bolt and tighten the nut to 80 ft-lbs with a torque wrench.

e) in a similiar manner, install rock bolts in every sixth pipe section along the length of the repaired section.

f) install U-rods along the length of the repaired cable by drilling 2-1/4" diameter holes, 18" deep on opposite sides of the split pipe. The holes will be drilled every 18 feet using the drill jig shown in figure 21.

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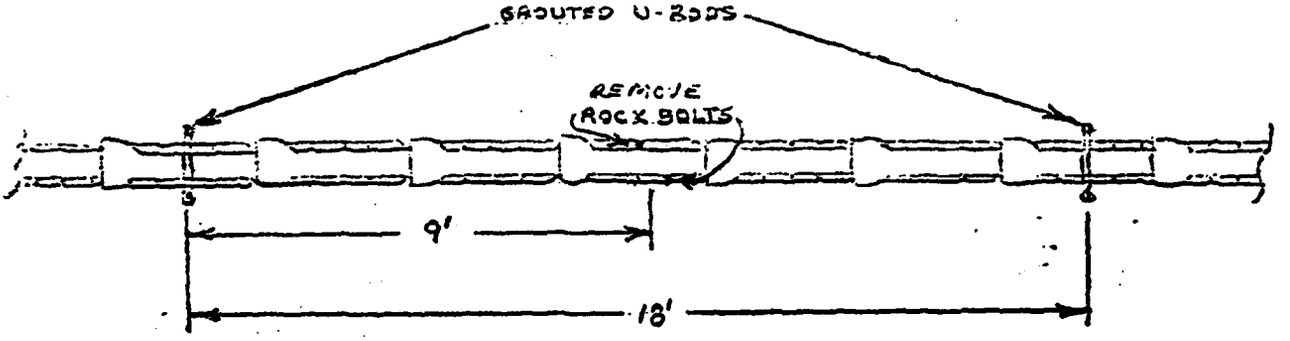

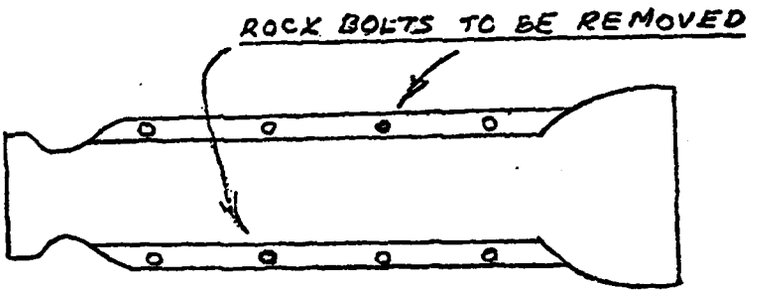

SPLIT PIPE - STABILIZATION

FIGURE 20

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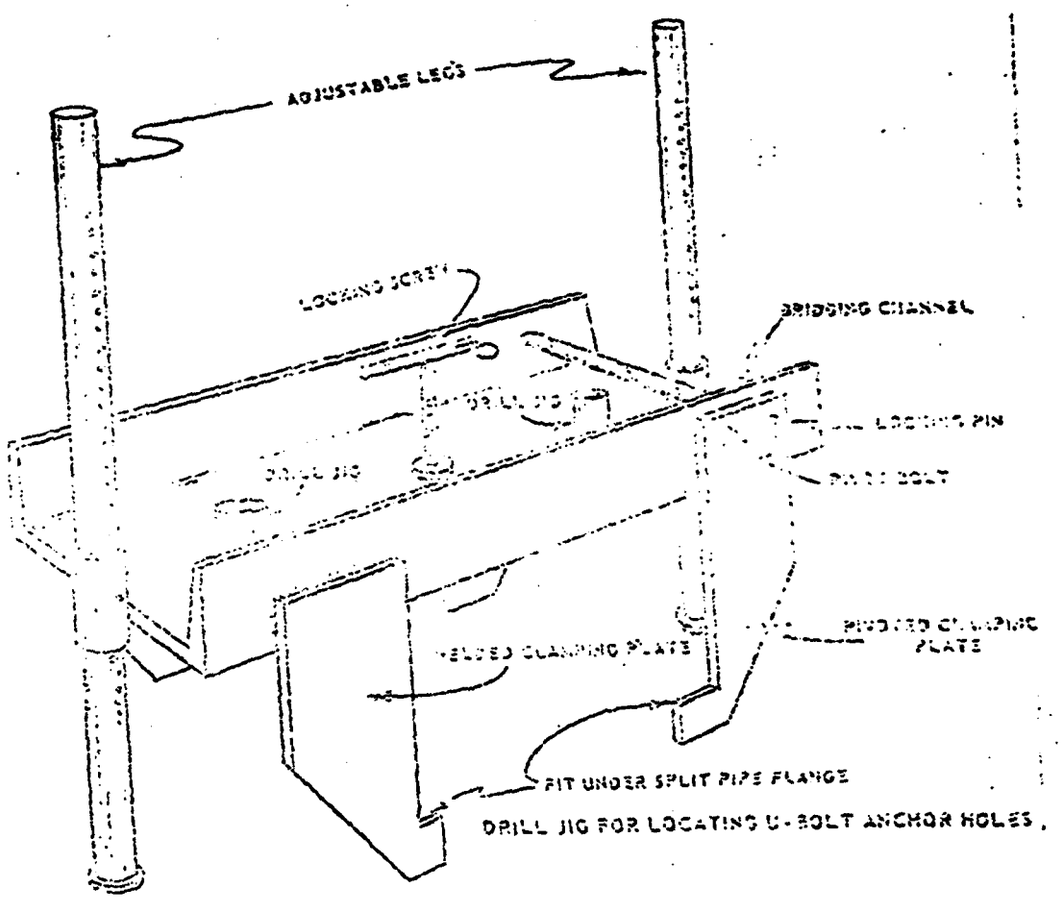

DRILL JIG FOR LOCATING U-ROD ANCHOR HOLES

FIGURE 21

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g) place U-rods over split pipe and fasten in drilled holes filled with grout. The grout will be mixed in the proportion three quarts of cement to thirty-three ounces of water. The grout will be mixed in polyethylene tubing onboard the LCM-6 and sent down on a messenger line to the divers installing the U-rods.

No immobilization is required on sandy bottom.

84. Inspect the entire repair cable section for stability.

85. Inspect entire cable, and where necessary replace U-rods and rock bolts.

4.4 Cleanup

The following post-operational tasks will be effected:

- o Clean up and secure beach station.
- o Transit LCM-6 back to staging area.
- o Packup and stage equipment and material.
- o Transit construction team, equipment and material to home port.

5.0 Task Assignment

The operational task assignments for the cable repair are shown in figure 23.

6.0 Project Schedule

The project schedule, including Alternative A, Alternative B and the Contingency Plan is shown in figure 24.

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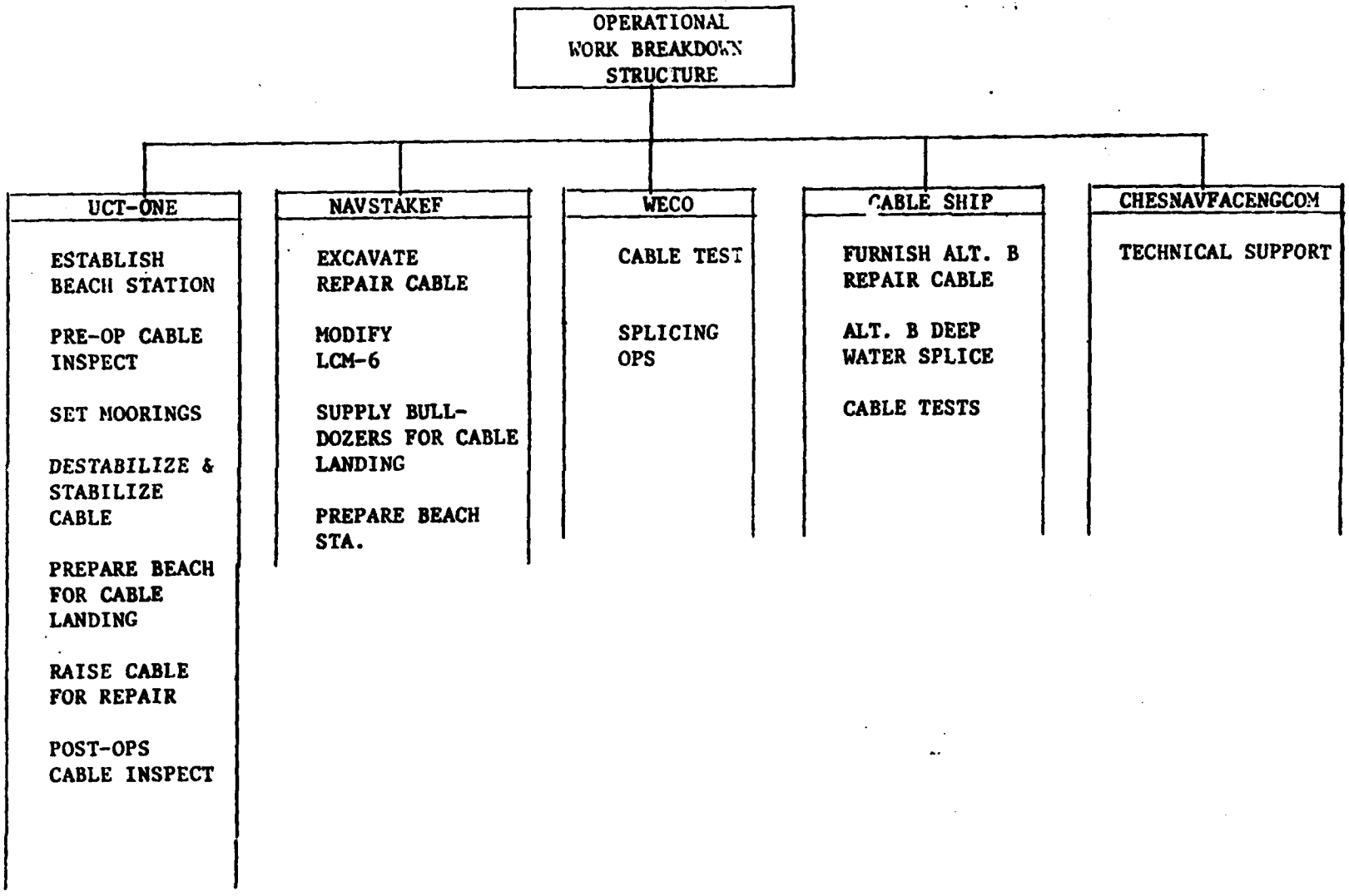

OPERATIONAL WORKBREAKDOWN STRUCTURE

FIGURE 23

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7.0 Financial Management and Costs

CHESNAVFACENGCOM has the responsibility for financial management of project funds. NAVELECSYSCOM, the customer, has transmitted funds to CHESNAVFACENGCOM for transfer to COMCBLANT, CEL and NAVSTA as required.

COMCBLANT will procure material and equipment, consumables, fabrication (drill jigs and pad-eyes), travel and per diem (for UCT-ONE), and equipment refurbishment. CEL will provide in-house engineering, design and material fabrication. CHESNAVFACENGCOM will provide in-house engineering and design servi... material procurement, and travel and per diem for on-site technical support. NAVSTA will provide on-site logistic support and services.

The following expenditures are the costs estimates for the project:

1.	COMCBLANT expenditures	$92,000
2.	NAVSTA expenditures	$22,000
3.	CEL expenditures	$ 3,000
4.	CHESNAVFACENGCOM expenditures	$11,000
		$128,000

In order to provide accurate accounting to the customer, all expenditures should be reported to CHESNAVFACENGCOM as soon after completion of the project as possible. A final analysis of cost will be made by correlation of actual expenses with the initial cost estimate. This analysis will provide a valuable tool in the development of future project plans.

8.0 Reporting

Situation reports (SITREPS) of project operations will be forwarded in accordance with the applicable fleet operations order.

A final project report will be prepared by CHESNAVFACENGCOM and forwarded to NAVELECSYSCOM two months after the field operations have been completed.

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APPENDIX A

SITE DESCRIPTION

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A.2 ENVIRONMENTAL SCENARIO

This scenario is intended to describe the environmental condition that may be expected during the months that the cable repair will be effected. The following environmental factors are discussed:

- o Climatology.
- o Monthly percentage frequency of occurrence of precipitation according to wind direction, wave direction.
- o Mean values of: wind speed according to wind direction, wave height according to wave period, precipitation.
- o Air and sea surface temperatures.
- o Persistence data for gale force winds.
- o Mean tidal range.
- o Surface Current Speed.
- o Precipitation (inches of).

) Upon arrival at the Naval Station, liason should be established with the local Navy weather station so that current weather forecasts are made available throughout the cable repair operation.

A.2.1 CLIMATOLOGY

There is no spring or autumn seasons as experienced in the middle latitudes. Rapid transitions between the two seasons take place during April and October. During these transitions, major storm tracks are located about 15° North Latitude due to West-East flows at levels aloft.

The duration of the summer season is essentially from May thru September. Summer weather, although wet, is characterized by lighter winds and milder temperatures compared to the transition period. Fog occurs more frequently during the months of June and July where a light, warm, southerly maritime tropical air flows over the relatively cooler North Atlantic Ocean. High humidity, steady rain, drizzle, fog, low ceiling and low visibility are characteristics of the Maritime Tropical summertime air mass. Many potentially pleasant summer days are tempered by the restrictions on temperature imposed by the cooler sea breeze. Diurnal temperature changes are minimized by the maritime climate. Mid-summer days are on the order of 20 hours in length. Although thunderstorms are rare, occurrence on the order of one per year can be expected in the vicinity of the Naval Station. Lying below the Arctic Circle, the sun always sets. However, twilight is bright during the months of June and July such that normal outdoor activities may be carried out without artificial light all night long. Particular meteorological characteristics offshore from the Naval Station are presented in succeeding pages.

A.2.2 MONTHLY PERCENTAGE FREQUENCY FOR THE OCCURRENCE OF THE FOLLOWING:

a) General

Parameter	June	July	Aug	Sep
No Significant Weather	82.1	84.3	87.4	82.5
Precipitation	12.9	9.6	10.9	13.4
Freezing Precipitation	0	0	0	0
Fog and/or Smoke	5.0	6.1	1.7	4.1
Winds $\leq$ 10 kts	50	55	60	45
Winds $\geq$ 17 kts	17.8	14.9	15.0	24.2
Winds $\geq$ 28 kts	1.0	.3	.3	3.3
Winds 4-10 kts, tmp $>32^{o}$F, No Precipitation	14.0	14.9	15.6	11.7

b) Wind Direction

Quadrant	June	July	Aug	Sep
N	9.6	16.4	17.0	13.7
NE	8.6	10.8	17.2	16.9
E	13.7	9.7	13.6	18.4
SE	16.2	11.6	12.3	12.4
S	12.1	9.3	8.3	9.6
SW	12.6	10.2	8.0	11.0
W	12.7	12.6	8.4	8.0
NW	10.5	14.6	11.0	7.8
Calm	4.0	4.8	4.2	2.2

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c) Visibility (nautical miles)

Distance	June	July	Aug	Sep
< ½	2.9	2.9	0.7	1.0
½ < 1	1.8	1.7	0.9	1.5
1 < 2	2.2	2.0	1.5	2.7
2 < 5	10.2	7.6	6.1	8.9
5 < 10	24.6	24.6	19.0	25.3
10 +	58.3	61.2	71.8	60.8

d) Sea Heights (ft)

Heights	June	July	Aug	Sep
<1	12.1	20.7	18.9	8.7
1-2	22.4	21.3	24.0	26.0
3-4	24.4	22.4	20.6	16.4
5-6	15.4	16.0	15.9	9.9
7	8.7	9.5	7.7	9.2
8-9	8.7	5.3	5.7	9.4
10-11	3.6	2.4	2.9	6.9
12	2.0	.4	3.1	4.6
13-16	2.8	2.0	1.2	5.9
17-19	0	0	0	1.1
20-22	0	0	0	.8
23-25	0	0	0	1.2

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< 8	83	90	90	70
< 12	95	97	96	86

e) Precipitation according to Wind Direction

June

20% of NE Winds accompanied by Precipitation

19% of E Winds accompanied by Precipitation

19% of NW " " " "

17 of N " " " "

July

20% of E Winds acompanied by Precipitation

19% of NW " " " "

18% N " " " "

18% of E " " " "

August

25% of SE Winds accompanied by Precipitation

23% of S " " " "

17% of N " " " "

17% of E " " " "

September

38% of SE Winds accompanied by Precipitation.

35% of E " " " "

30% of NE " " " "

30 of S " " " "

f) Wave Direction

June

30% all waves are from the South

(1) 13% waves are 4-6ft high from S

(2) 11% wave are 6-10 ft high from S

July

23% all waves are from southeast

(1) 10% waves are 4-6 ft high from SW

(2) 7% waves are 6-10 ft high from SW

August

21% all waves are from N

(1) 9% waves are 4-6 ft high from N

(2) 7% waves are 6-10 high from N

September

19% all waves are from northeast

(1) 4% waves are 3-6 ft high from NE

(2) 6% waves are 6-10 ft high from NE

(3) 8% waves are 10 ft high from NE

15% all waves are from southeast

(1) 3% waves are 3-6 ft high from SW

(2) 5% waves are 6-10 ft high from SW

(3) 7% waves are 10 ft high from SW

A.2.3 MEAN VALUES

a) Wind Speed (kts)

Direction	June	July	Aug	Sep
N	11.2	12.6	12.5	14.2
NE	11.2	12.8	12.3	14.1
E	13.5	11.7	12.4	17.1
SE	12.4	10.4	12.0	15.4
S	10.0	11.1	10.2	13.4
SW	10.2	12.2	9.7	15.0
W	9.9	9.6	9.9	11.8
Calm	10.6	10.7	10.8	14.3

b) Precipitation

	June	July	Aug	Sep
Total (inches)	2.4	2.2	2.2	4.4
Number Days $\geq$ .1 inches	7.2	7.4	6.3	9.9
Number Days Thunderstorms	0	.1	.1	.2

A.2.4 TEMPERATURE (F)

a) Air Temperature

	June	July	Aug	Sep
Absolute Maximum	85	74	68	63
95% $\leq$	55	57	56	54
Mean	48.8	51.9	51.7	48.7

5% ≤	44	48	46	43
Absolute Minimum	33	38	35	30
Mean Number Days ≤ 32 °F	0	0	0	.5

b) Sea Surface Temperature

	June	July	Aug	Sep
99% ≤	53	55	57	55
Mean	47	50	47	42
1% ≤	40	43	47	40

A.2.5 PERSISTENCY

a) Duration of gales (hrs)
(Winds ≥ 34 kts)

	June	July	Aug	Sep
98%	18	17	36	42
92%	12	11	14	24
80%	6	5	10	12
60%	3	4	7	6
30%	2	2	3	4

b) Number Days Interval Between Gales
(Winds 34 kts)

% Gales	June	July	Aug	Sep
85	40	48	28	14
80	28	40	24	10

70	16	21	14	8
50	8	10	14	4
30	4	2	7	2

A.2.6 MEAN TIDAL RANGE

The mean tidal range is 9.0 ft.

A.2.7 SURFACE CURRENT SPEED

a) 40 - 55% from SSE at 0.5 kts

b) 95% 1 kt

c) 5% 1 - 19 kts

A.2.8 PRECIPITATION (INCHES)

a) Rain

	June	July	Aug	Sept
Mean	2.9	2.5	3.2	4.4
Maximum	6.2	5.1	7.2	10.4
Minimum	.5	.7	.4	.9
Maximum in 24 hours	1.7	1.1	3.4	2.2

b) Snow (inches)

	June	July	Aug	Sep
Mean	Trace	Trace	Trace	.2
Maximum	Trace	Trace	Trace	1.9
Minimum	0.0	0.0	0.0	0.0
Maximum in 24 hours	Trace	Trace	Trace	1.6

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A.3 INSPECTION/SURVEY RESULTS

Figure A2 shows the path of the cable from the cove area to sea and identifies the location of a previous cable repair, strengthening of a worn area, and the present problems. The figure also shows the relative position of the cable.

A.3.1 RESULTS OF CABLE REPAIR AND STRENGTHENING, AUG-JUNE 1973.

The cable was repaired by splicing at a distance of approximately 0.65 nm from the building in 1973. After the repair was completed an inspection of the cable was conducted. The cable was inspected from the south side of the south sandbar for a distance of 2020 feet. The continuous pipe and U-rods end 918 feet from the south side of the south sandbar. In this segment, several areas with missing pipe were discovered. 681 feet from the sandbar two sections were missing from under a U-rod which had not been installed tightly against the top of the pipe. The loose pipe sections had slid from under the U-rod and the cable had abraded against the rod. All the outer and four of the inner armor wires were completely worn through. Two were worn through halfway, leaving nine good inner wires. The U-rod had abraded through the outer polyethylene, the steel tapes, copper tapes, and into the inner polyethylene. From 918 feet (end of continuous pipe) out to a distance of 1500 feet from the sandbar, pipe and U-rods were observed on rock outcroppings. From 1500 feet to 2020 feet from the sandbar, no pipe or U-rods were observed. On several rock outcroppings the outer armor wires were worn 1/3 through. Near the end of the inspected segment of cable a sub-surface buoy on a six foot 6-thread pennant was found, indicating little wave motion at that point.

The badly worn spot mentioned above was two feet south of a 35 foot suspension. Two sections of pipe were removed south of the worn spot, and two sections north, to expose 18 feet of cable. The U-rod that had caused the worn spot was cut and removed, using the hydraulic grinder. A 2000 pound lift bag was tied to both ends of the pipe, using equal length lines, and inflated. The addition of two slit float balloons at the north pipe end and one at the south end raised the cable sufficiently off the bottom to facilitate repair. The outer armor wires were banded and clipped back on each side of the worn spot such that their ends were about 12 feet apart. The parted inner armor wires were clipped back and four 18 inch pieces of inner armor wire were laid in place and secured using stainless steel banding material. Eleven foot three inch outer armor wires were then laid in place and secured using stainless steel banding. After applying split pipe, the balloons and lift bag were deflated and the cable placed on the bottom. The entire repair was completed in one afternoon.

A pair of rock bolts and U-rods were also installed at the worn spot. In order to strengthen the suspended cable section, a steel A-frame was bolted to the pipe and rock-bolted to the bottom, halfway across the adjacent suspension. In addition to reducing cable movement, the A-frame was designed to raise up the center of the catenary in line with the two ends, thereby greatly reducing the tension in the weakened cable. The remaining missing pipe and missing/loose nuts and bolts were replaced, with one exception: 620 feet from the sandbar (60 feet north of the worn spot), the cable changes types At this point the cable diameter, because of the splice, increases to four inches and therefore two sections of split pipe could not be installed. However, the cable is suspended at that point and leather chafing gear was wrapped between the cable and the male end of the pipe (on the north end of the suspension).

A.3.2 RESULTS OF — CABLE INSPECTION, AUG - SEPT 1974

The cable was inspected in late August and early September 1974. The inspection was terminated early because of bad weather. It was noted that the zinc anodes on the rock bolts were missing. Throughout the length of the cable, yet all rock bolts were tight.

A.3.3 RESULTS OF — CABLE INSPECTION, APRIL 1976

The April 1976 inspection identified the following:

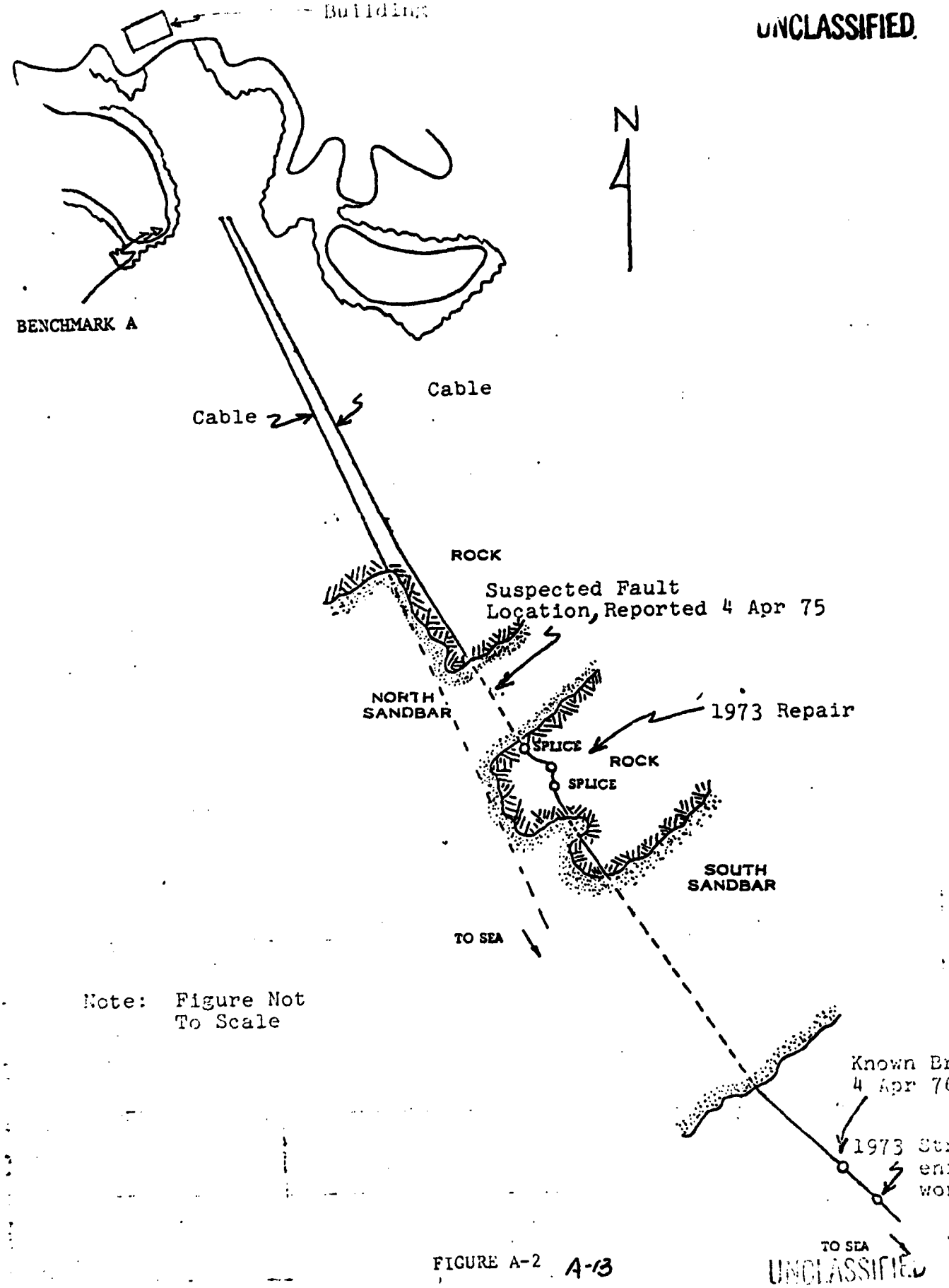
- a known break in the cable approximately 123 feet south of the southern sandbar.
- in the area of the suspected fault, at 0.6 nm, the cable was buried in the north sandbar.

In addition, the existing cable immobilization was inspected for the purpose of analyzing the merits of U-rods versus rock bolts. Virtually all U-rods and rock bolts were intact and holding the cable to the seafloor. No anodes were apparent on the rock bolts. Most rock bolts also showed some degree of corrosion (as much as 25%) in the area covered by the split pipe flanges.

A.3.4 SURVEY RESULTS

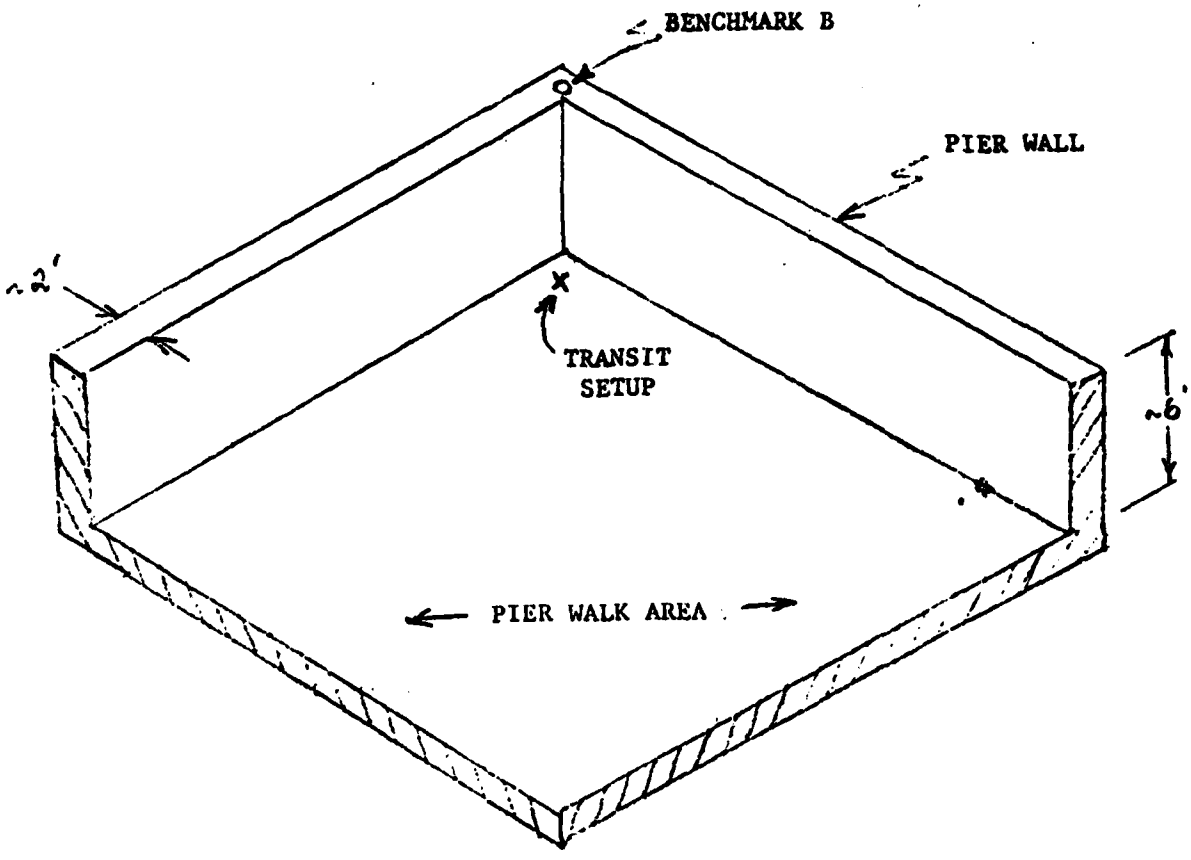
There are two known benchmarks in the vicinity of the cable repair area. Benchmark A is on the southwest tip of the cove as shown in figure A2. Benchmark B is located in the inside corner of the fishing pier wall as shown in figure A3.

Bearings have been taken between the two benchmarks and from each benchmark to two other land locations: the southern edge of the southwest antenna and the Water Tower. Table 1 summarizes the survey results.



Note: Figure Not
To Scale

FIGURE A-2



NOTE: SKETCH NOT TO SCALE

LOCATION OF BENCHMARK B

FIGURE A3

TABLE 1

BEARING TO LAND LOCATIONS

LOCATION	BEARING
Benchmark A to Benchmark B	190°34'L
Benchmark B to Benchmark A	90°36'L
Benchmark A to antenna	0°
Benchmark A to NAS Water Tower	264°20'L
Benchmark B to antenna	86°53'L
Benchmark B to Water Tower	0°

Bearing have been taken from the known benchmarks to selected underwater locations. The survey results are shown in Table 2.

TABLE 2

BEARINGS TO UNDERWATER LOCATIONS

LOCATION	BENCHMARK A	BENCHMARK B
Northern Edge of North Sandbar	142°10'L	109°06'L
Southern Edge of North Sandbar	147°05'L	119°30'L
Northern Edge of South Sandbar	146°14'L	124°18'L
Southern Edge of South Sandbar	146°26'L	144°39'L

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APPENDIX B

REFERENCES

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APPENDIX C

MATERIAL AND EQUIPMENT (U)

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C.1 UCT ONE MATERIAL SHIPMENT

ITEM	QUANTITY
8 CFM HP Compressor	1 each
Compressor oil	21 gal
Spare parts for 8 CFM Compressor (extra bleed wing nuts)	
Spare filter elements for 8 CFM compressor	5 gal
Charging leads	1
Air intake extension	12 ft
Compressor covers or tarps	4 ea.
Jumper cables	2
5 gallon gas can with spout	5
Draeger gas analysis kit w/tubes	1
Twin 72's	16
Single 72's w/backpack	6
Extra manifold	5
Extra harness	3
Regulator repair tools	One box
Extra regulator, single hose	4
Extra regulator double hose	2
Dive superv. box	L.S.
Extra K-bars	6
Black magic, 4 oz. can	16 + 1 gal ca
Extra pair fins	3
Ambu bag	2
First aid kit	4
Diving superv. briefcase	1
Extra weights	376 lbs

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ITEM	QUANTITY
Extra weight belt	4
Dive brights	4
Signal flares	24
Extra gloves, diving	10 pr.
Civilian dive flag	6
M-80	100
2000 lb. lift bag w/90 cu ft bottles	3
Float balloons (for lift bags)	60
Diver tool bag	10
Photo gear	L.S.
Towels	36
Sledge hammer	2
LARC compass	1
Silicone spray + 15 tubes	10 cans
Pry bar 5'	3
Small buoys	25
WD-40	24 cans
Garden hose	900 ft
PRC-77's (or 25's) w/antenna	6
Hand sets	6
Headsets	6
Extra batteries	24
Extra antenna	2
Float balloon fillers	1
K bottle charging lead	1
Hydraulic power source	1

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ITEM	QUANTITY
Hydraulic oil (5606 B)	2-55 gal drums
Hydraulic hose	200 ft.
Fittings	L.S.
Spare parts for hydraulic power source	L.S.
Hydraulic impact wrenches	3
Hydraulic grinder	2
Hand pump (oil drum)	2
Disc for hydraulic grinder	24
Complete mechanics tool box w/lock	1
VOM	2
Grease gun, full	2
Valve stem core remover	6
Black tape	24 rolls
Assorted nuts, bolts, screws	
3/4" electric drill with bits	
Zodiac 1-19', 2-12'	3
Oars	
Foot pump	
Zodiac patch kit	
Zodiac pressure gauge	
15 lb. anchor	3
50 lb. bottom clumps	3
85 Hp Outboard	2
6 gallon gas tanks	4

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ITEM	QUANTITY
25 HP outboard	2
3 gallon gas tanks	3
Outboard motor oil	3 cases
Outboard spare part	L.S.
1/4" shackles	10
3/8" shackles	4
1/2" shackles	10
3/4" shackles	12
5/8" shackles	50
1-1/8" shackles	12
Seizing wire	12
Wire rope 5/8"	2000' 2 coils
2" dia. line/wire rope snatch block	3
7/8" snatch block wire rope	1
6 thread	1 coil
2-1/2" circum.	2 coils
3" Samson stable braid	3000 ft.
1/2" nylon	1 coil (600')
Polypro 3"	5000'
Air tugger winches (1200 lb)	2
1/4" polyp..o	1 coil (600')
Marlin spikes	6
Wire rope clips 5/8"	100
Work gloves	20 pr.
Wire rope cutter	1

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ITEM	QUANTITY
Turnbuckles 5/8"	10
Pelican hooks (10 ton)	2
Padlocks	6
Bull horn w/batteries	1
Extension cord	200'
Band mask Mark I Assy	3
Lightweight diving shoes	4 pr.
Lightweight belt	5
Boat hooks	5
Fathometer + 6 rolls paper	1
Binoculars	2 pr.
15/16 socket, deep/thin wall	24
Ratches, spud	10
Open end 15/16 spud wrenches	12
Coffee thermos	3
Small BTL stopper	6
Transit w/tripods	2
Come-along (1-1/2 ton)	2
Grip hoist, T20, 3300 lb capacity, FSN 3950-729-6165	1
Grip hoist, T15, 1650 lb capacity	1
Portable tool room	2
Personal dive gear	1 set/diver
Pneumatic impact wrench	2

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ITEM	QUANTITY
Air hose, 1" x 50' w/fittings	600 ft.
Unisuit with gloves	6 ea.
Ladder, LARC V diving	1 ea.
Pot coffee, 20 cup	1 ea.
BU Kit	1
Bow troughs	2
Work life jackets	30
U/W tool kit	1
U/W tools	1 bx
3/4" drive socket	1 set
Chain binders	8
Hard hats	24
CE kit	1
Complete hydraulic pkg. NAVSEA	1
SW kit	1
Ball trailer hitch	1
ET kit	1
Reg. HP for chamber	2
Bolstad filters	5
2" x 4" lumber	400 lf.
1/2" plywood	12 sh.
16d nails	50 lbs.
LARC	1
16' Boston Whaler	1
Chamber	1

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ITEM	QUANTITY
Comp. Van	1
24 CFM compressor (tlr mtd)	1
Gas can hoses	7
Padeyes	20
Manila line 1-3/4"	1 coil
Manila line 3/4"	2 coils
Drill steel 2'	6
Drill bits 2-1/2"	8
Drill bits 2-1/4"	24
Drill steel 4'	6
Drill steel 3'	12
1/2" wire rope	1 coil
Parts bin	1
Bow rack	1
Oil, preservative	12 ea.
Oil, corrosive preventative	12 ea.
Reel stand	1
Angle iron 2" x 2" x 19'	2 lengths
Steel sheet 4' x 4' x 1/2"	1 sh.
Steel sheet 4' x 4' x 3/8"	1 sh.
6" polypro	1 coil 3000'
2" polypro	1 coil 2000'
Pneumatic rockdrills	3 ea.
Battery D cell	72

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ITEM	QUANTITY
Dwell/Tach meter	1
Spectacles	24 pr.
Funnel	2
Fire ext.	4
Cups, hot drink	1 case
Hand cleaner	6 cans
Extreme cold weather gear	21 sets
10" pipe wrench	2 ea.
Tape measure 100'	2
Anti-seize tape teflon	
Snap swivel	4
Vise grips 7"	3
Adj wrench 6"	6
Mallet	1
3/8" shock cord	200'
3/8" fittings for shock cord	50
Polyethylene sheets 100' x 12'	3 ea.
Hydraulic cement 5 gal	10 ea.
Rags	2 bundles
Torque wrench	2
American flag	1

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C.2 NAVELECSYSCOM MATERIALS

Material directly shipped from Cheatham Annex to to arrive no later than 15 June as per fonecon between LT Marshall and Mr. Ken Willett, MSCO Norfolk (A 690-2377/3959) on 13 May 1976.

Item	Quantity
1. Split pipe	35 pallets
2. Nuts, bolts, washers	6000 ea.
3. 8 x 3 line (total 1 mile)	2 reels
4. 3/4" or 7/8" tapered chain stoppers	2
5. Large BTL stoppers	4
6. Orange float balloons	335

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C.3 WECO MATERIALS

Material directly shipped and is the total responsibility of WECO

Item	Quantity
1. Splicing tools and equipment	as necessary
2. Lead sleeves	as necessary
3. Splices	as necessary

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C.4 OCEAN CONSTRUCTION EQUIPMENT INVENTORY MATERIALS

	Item	Quantity
1.	Small hole rock drill	1
2.	Radios - 220's	4
	PT 400's	2
3.	Orange float balloons	100
4.	Tool Kit	1
	Including the following items: Power Tools as follows.	
	NAVSEA Portable Hydraulic Unit	1 ea
	Impact Wrench, 6 HS	2 ea
	Combination grinder/Abrasive cutter, 24HS	1 ea
	50' hose lengths (2651-12)	2 ea
	200' hose on reel (3R80-12)	1 ea
	Grind wheels/cut-off wheels	1 set
	Impact Sockets w/adapters	1 set
	Misc support mat'l & spares	1 set
	Drum oil (55 gal), MIL-H-24430	1 drum
	Flow divider (for 2-tool operation)	1 ea
	Intensifier, hyd (10,000 psi)	1 ea
	Sump pump w/hose and jetting nozzles	1 set
	Come-a-long, hyd, 1 ton	1 ea
	Storage/shipping boxes	3 ea
	Diver Powered Tools	
	Pump, diver powered	1 ea
	Bar cutter, 5/8"	1 ea
	Wire rope cutter, 1-1/8"	1 ea

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Item	Quantity
Diver Powered Tools - continued	
Rams (2 ea)	1 set
Pull cylinder (5 ton)	1 set
Hose, 100' (10,000 psi)	1 ea
Hose, 10' (10,000 psi)	1 ea
Misc support material	1 set
Storage/ship box	1 ea
Support Equipment	
NAVSEA 750E variable/constant buoyancy lift bag	1 ea
Rock drill, pneumatic (back up and no surface support ops)	1 kit
Packaging, Assembly, Manuals, etc.	

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C.5 CHESNAVFACENGCOM MATERIAL SHIPMENT

Item	Quantity
1. S/S bolts 5/8 - 11	3500
2. S/S nylock nuts 5/8 - 11	3500
3. S/S U - rods and nuts	60
4. 5/8" x 12" wedge anchors	200

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C.6 CEL MATERIALS

Item	Quantity
Blind bolts 5/8" ϕ	160 ea
Rock bolts	
3/4" x 7	42 ea
5/8" x 12	22 ea
Tool box	1 ea
Spare parts box	1 ea
Misc fittings box	1 ea
Hydraulic power converter	1 ea
Hose whips	3 ea
Flow meter	1 ea
Pressure relief valve	1 ea
O-Ring kit	1 ea
Hand held rock drill kit	1 ea
Dial torque wrench 3/8 dr. 250 in. lb	1 ea
Size 40 hoseclamps	13 ea
Almagard #3752 (tubes)	7 ea
Bandsaw	2 ea
Band saw blades 10 T.P.I.	14 ea
ROK bits 3"	2 ea
ROK bits 2 1/4 "	2 ea
ROK bits 2"	3 ea
Adapters	3 ea
Pilot bit	1 ea
Reaming bit 3"	1 ea
Reaming bit 2 1/2"	1 ea

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Item	Quantity
Drill steel 2'	2 ea
Blind bolt tool	1 ea
Grease gun	1 ea
Nut splitter kit	4 ea
WD 40	1 case
Hammer, 3lb	1 ea
Wrench, pipe	1 ea
HP Hydraulic hose	200 ft
M. P Hydraulic hose	200 ft
Pneumatic hose	150 ft

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C.7 ON-SITE EQUIPMENT AND MATERIALS

	Item	Quantity
1.	3' x 3' x 3' 4000 lb concrete clumps	6
2.	500 lb mushroom anchors (1 on beach, 2 at weapons)	3
3.	20" x 5/8" wedge anchors	50
4.	Pallets split pipe (40 sec/pallet) (at weapons)	21
5.	Miscellaneous: uninventoried mooring hardware (buoys, shackles, grapnels) (at weapons and PW)	

AD-A165 483 PROJECT EXECUTION PLAN FOR NORLANT REPAIRS(U) NAVAL FACILITIES ENGINEERING COMMAND WASHINGTON DC CHESAPEAKE DIV 31 MAY 76 2/2

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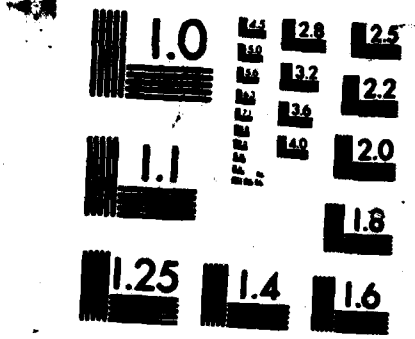

MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

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C.8 LCM-6 MODIFICATION MATERIAL AND EQUIPMENT

Item		Quantity
1.	Lumber, 2" x 8" x 14'; rough	56 boards
2.	Lumber, 4" x 4" x 40'; timber support	1 each
3.	Iron, Angle, 2" x 3/8"	80 feet
4.	Lumber, 4" x 4" x 7'	8 each
5.	Cabinets, weather tight, 3' x 8' x 5' high	2 each
6.	Padeyes, made from 1/2 rebar	4 each
7.	Chock, gated, steel	4 each
8.	Tripod, 3' high, steel	4 each
9.	Bolts, 1" x eye, 1" ID in eye, 8" long with 6" of bolt threaded	10 each
10.	Hatch, wood, 3' sq. 2" thick, hinged	2 each
11.	Ladder, 7' long, 2' wide, 2" x 4" lumber	2 each
12.	Lumber, 2" x 4", 160 linear feet	160 Lin ft.
13.	Tarpaulins, 14' x 14', approx.	3 each
14.	Tent, 12' x 35' minimum 7' high at center line, aluminum frame (light steel may be substituted)	1 each
15.	Lights, cargo, cluster, with sea plugs and wiring to generator	4 each
16.	Plywood, 1", 4' x 8' sheets	3 each
17.	Horse, 2 legged, 40" high, collapsible	10 each
18.	1/2" wire rope, 40' long	1 each
19.	Turnbuckles with sister hooks	2 each
20.	Stan. 5' high	14 each

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Item	Quantity
21. 30 KW diesel generator	1 each
22. Air tugger, 1200 lb	1 each
23. Air compressor, diver's	1 each
24. 300 CFM compressor	1 each
25. Hydraulic power source	1 each

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APPENDIX D

WELDING PROCEDURES FOR SPLIT PIPE REPAIR

D.1 WELDING PROCEDURES FOR SPLIT PIPE REPAIR

Ref: (a) Welding Procedures for Split Pipe Repair by E. S. Silva dtd 13 July 1972.

The following procedure modifies reference (a).

D.1.1 CUTTING CAST IRON SPLIT PIPE

D.1.1.1 Hacksaw:

- power driven is preferable

D.1.1.2 Oxy-Acetylene Torch:

- cast iron can be cut with an oxy-acetylene torch
- more preheat is needed than for cutting steel
- use a big preheating nozzle
- a carburizing preheat flame is favored
  - use excess acetylene to produce a long white feather beyond a small conical inner flame
  - The length of the streamer should be approximately equal to thickness of the cast iron being cut
  - Figure D-1 illustrates the situation

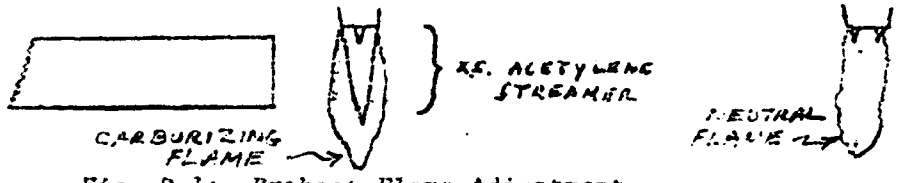


Fig. D-1: Preheat Flame Adjustment

- In order to enhance metal removal by errosion, the flames must be oscillated
  - a motion in the form of cresents is preferred
  - Figure D-2 illustrates the motion

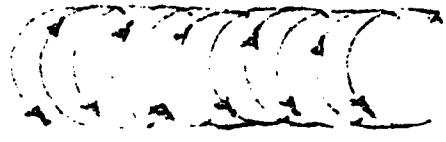


Fig. D-2: Flame Motion for Cutting Cast Iron

- if have difficulty cutting, can add iron or low carbon steel to the system to provide heat of oxidation and assist the cutting process by providing sufficient heat to melt the oxides
  - Feed a small low carbon steel wire into the flame to act as a steel particle source
  - put iron powder into the flame with a low pressure air source

D.1.1.3 Shielded Metal-Arc Cutting:
- use a cutting electrode such as Hobart "Cut-Trode"
  - use 5/32 in. or 3/16 in.
  - use manufacturer's recommended current and AC polarity for cast iron
  - (if can not obtain cutting electrodes can use E6010, E6012 or E6020, but cutting electrodes strongly recommended)
- cut a deep groove with a single pass of the arc, and then ban with hammer to break off the pieces like cutting glass
- can also make repeated passes until cut through, but beware of cracking if the work gets hot and cools rapidly

D.1.1.4 Oxy-Arc Cutting:
- this requires a torch with an air or oxygen jet down the center of tubular electrodes
  - an underwater cutting torch will have this feature and may be included with UCT diving equipment
- need tubular electrodes of steel or ceramic material
  - 5/32 in. or 3/16 in. steel recommended
  - use 90-150 amp. with 5/32 in. and 150-200 amp. with 3/16 in.
  - use AC, with DCRP as a less optimum second choice
- prefer air at 80-100 psi, but can use as low as 40 psi

D.1.2 JOINT PREPARATION

D.1.2.1 Remove casting skin, marine growth, rust, and foreign materials from the joint surfaces and surrounding areas with a grinder, chipping unit or heavy duty carbide sander

D.1.2.2 Remove all oils, grease, and water from the joint area with solvents or by heating at approximately 750°F until all volatilization stops.
- if have problem remvoing gaseous products, can flash heat to 1000°F to drive them off.

D.1.2.3 Cut all cracks out
- use grinder or any other tool that suits the situation and vee them out or remove cracked sections.

D.1.2.4 Machine, grind, or chip a single-Vee groove with a 30° bevel, 1/16 in. root opening, and 1/16 in. land as shown in Figure D-3.
- total opening should be 60°, and not exceed 80°
- use of an oxy-acetylene torch for this will be difficult and produce a rough scarf, but can be done if no other alternative

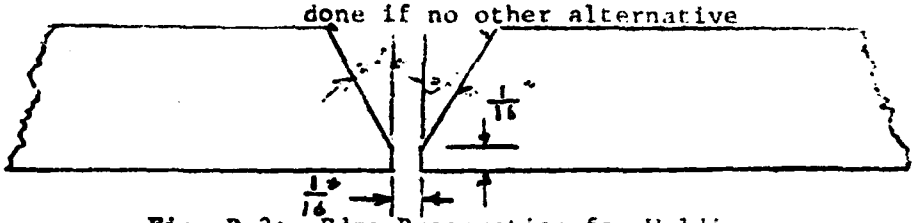


Fig. D-3: Edge Preparation for Welding

D.1.3 PREHEATING:

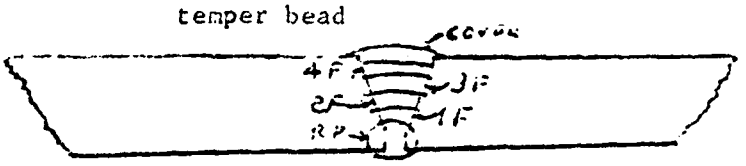
D.1.3.1 Mark the pipe in the vicinity of the proposed welds with 400°, 500° and 700°F temp. sticks

D.1.3.2 Play an oxy-acetylene torch over the joint area and try to heat the piece evenly to the 400°F range
- should cracking occur, try more uniform preheat
- bear in mind that the marks are on the surface of the pipe and want uniform heating throughout the piece so do not hurry this operation
- should the joint area drop below 400°F during cleaning between passes, immediately reheat the piece to the 500°-700°F range before attempting to resume welding

D.1.4 WELDING:

D.1.4.1 Make all passes with ENiFe-CI electrodes as follows:

PASS	ELECTRODE DIAMETER (in.)
stringer or root	5/32
first filler	5/32
second filler	5/32
third filler to cover	3/16
temper bead	5/32 (see Fig. D-4)



- anticipated welding currents for 5/32 in. electrodes should range from 120-130 amp., and for 3/16 in. electrodes from 140-150 amp.
- use DCSP or AC. It is best to try the electrode manufacturer's recommended currents first
- use currents as low as possible consistent with smooth operation, good bead contour and just enough "wash" to minimize slag inclusions

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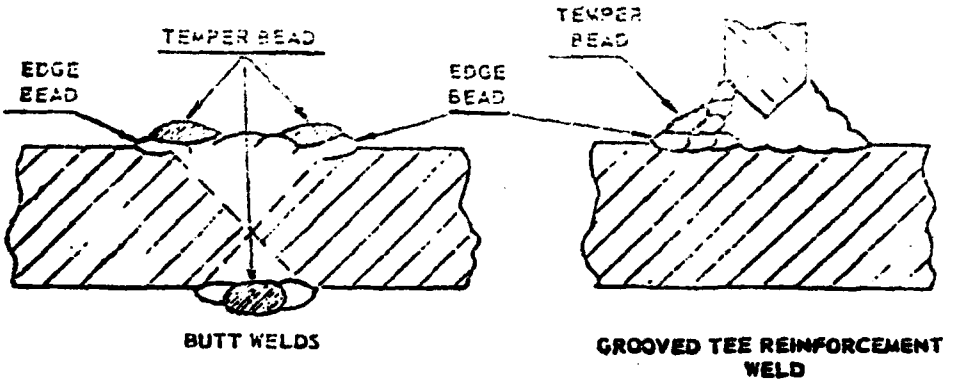

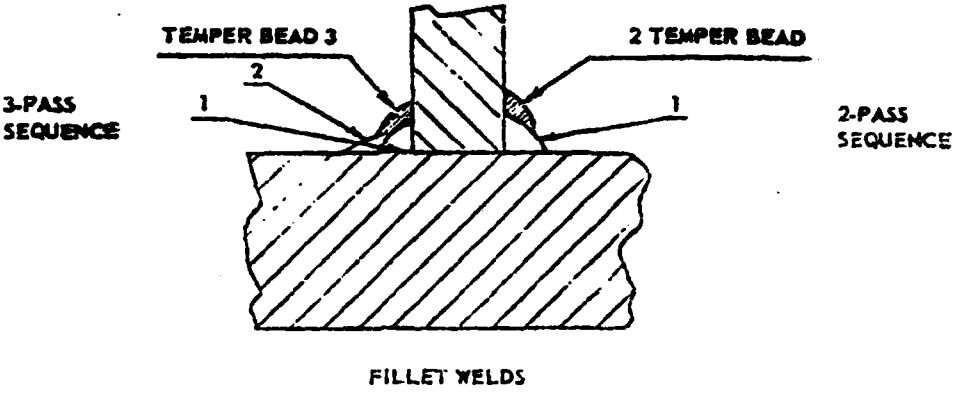

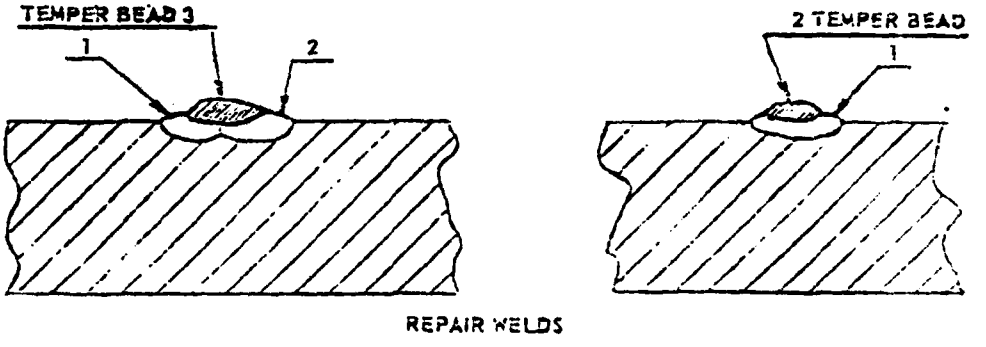

Figure B-4: Typical bead deposition for tempering effect. (Not to scale)

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D.1.4.2 If the root pass is significantly porous or cracked, it must be removed
- grinding out the bad portions is the usual method

D.1.4.3 Repeat the welding and removal operation until the root pass is sound.
- it is possible that porosity or cracking will not occur on the first attempt; in which case, just continue on with the welding

D.1.4.4 Continue welding
- manipulate the electrodes so that the width of the deposit is not greater than 3 times the electrodes diameter (15/32" or 9/16")
- try to avoid high dilution by using low currents and this confined manipulation
- use continuous welding to maintain 500°F preheat
  - Only weld when material has adequate preheat
    - can retard cooling between passes by wrapping with asbestos or welding overheated sand, etc.

D.1.4.5 Apply temper or annealing beads, Fig. D-4
- place bead on top of the weld on the periphery of the deposit
- confine bead to previously deposited weld metal such that no base metal is melted
- use 1/8" or 5/32" electrodes

D.1.4.6 Clean each pass with a wire brush and hammer to remove all the slag
- only peen lightly

D.1.5 POST-WELD TREATMENT

D.1.5.1 Since cannot furnace cool the welds, attempt to slow down the cooling by covering the finished weld with asbestos (as burying it in hot sand, if possible)
- cool the weld area uniformly
- covering must have no vents or leaks to allow drafts to reach the welds
- UNDER NO CIRCUMSTANCES SHOULD WATER BE POURED ON THE JOINTS OR SHOULD THE WELDS BE WRAPPED WITH WET RAGS TO SPEED UP COOLING
- keep covered until weld is 100°F or less

D.1.5.2 Clean the weld with wire bursh and hammer
- if weld is peened, use a round-nose tool with just enough force to move the metal, but not enough to rupture the beads

D.1.5.3 Grind off the interior of the pipe with small diameter stone to avoid abrading the cable when the pipe is in service
- if the stringer pass is properly made, this requirement should be minimal

D.1.5.4 If a milling machine is available nearby, mill off the pipe faying surfaces to insure easy mating during replacement
- re-drilling the bolt holes might also be advisable

D.1.6 THE WELD

D.1.6.1

Expect approximately:	Parent Material:
- 70,000 psi T. S.	- 60,000 psi T. S.
- 49,000 psi Y. S.	- 45,000 psi Y. S.
- 12% Elong. in 2 in.	- 15% Elong. in 2 in.
- BHN of 175-200	- BHN of 162

D.1.6.2 Other techniques, such as brazing or gas welding, will be more difficult than the arc method or produce joints that a considerably weaker than the shielded metal-arc method.

D.1.7 EQUIPMENT LIST: (*Indicates some duplication, but is desirable)

- hand held air grinder or electric grinder and spare wheels
*- electric disk sander and hundreds of carbide disks if grinder not available
  - also useful for finishing work
- air chipper and spare chisels
- protective face shield and gloves for grinding and chipping operations
- air and electric power sources
- oxy-acetylene cutting torch with maintenance kit and spare tips
- oxy-acetylene gases and manifold system
*- oxy-acetylene or underwater arc cutting torch and maintenance kit
*- tubular electrodes for cutting
*- oxygen or air source for arc cutting torch
- hand held electric drill and high speed bits of various sizes
- hammer and punch for starting hole
- welder's gauge for 30° vee grooves
- wire bursh and welder's hammer
- 5/32 in. ENiFe-CI electrodes - at least 50 lbs depending on amount of welding expected
- 3/16 ENiFe-CI electrodes - at least 50 lbs.

- arc welder, electrode holder, ground clamp, cables (at least 300 amp capability)
- 400°, 500° and 700°F temp. indicating markers
- small diameter grinder for touch up inside the pipe
- asbestos cloth for wrapping joints
- protective clothing and helmet for the welder
- lens shades for helmet nos. 4, 5, 6, 8, 10, 12, 14
  - 12 and 14 for welding operations
  - others for cutting
- hacksaw and spare blades
- spare blades for power hacksaw near site
- files
- soapstone
- low carbon steel wire
- fire brick and asbestos sheet for work surface and blocking
- clamps and possible beam to clamp to
- FSN: Cast iron arc electrodes IHC 3439-165-4188 (5/32 x 14)

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